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No Migration Variances to the Hazardous Waste Land Disposal Prohibitions: A Guidance Manual for Petitioners

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"NO MIGRATION" VARIANCES TO THE HAZARDOUS WASTE LAND DISPOSAL PROHIBITIONS: A GUIDANCE MANUAL FOR PETITIONERS

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Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SOLID WASTE
WASHINGTON, D.C.

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Introduction

This interim final manual is intended to assist hazardous waste management facility owners and operators who may be considering petitioning the U.S. Environmental Protection Agency (EPA) for a variance from land disposal prohibitions at specific sites for specific wastes. The guidance manual also provides the EPA interpretation and suggested procedures to implement the regulatory standards and procedures set out in 40 CFR 268.6. Readers should note that this guidance document is only an Interim Final, and will be updated consistent with the final "No Migration" rule, scheduled for publication in September 1990. Thus, this draft guidance manual is not itself binding on the Agency, the regulated community, or the public. EPA will fully consider alternative approaches raised by the applicant or other interested parties to the extent consistent with existing regulations at 40 CFR 268.6, the Resource Conservation and Recovery Act, and other EPA regulations. This manual also contains descriptions of additional requirements for "no migration" petitions in the Land Disposal Restrictions First Third Rule promulgated on August 17, 1988 (53 FR 31138). The manual specifically does not address the requirements for "no migration" petitions for waste disposal in deep injection wells. Requirements for deep well injection specifically pertain to the unique technological and hydrogeologic conditions associated with injection. The reader should refer to the Underground Injection Control Rule promulgated on July 26, 1988 (53 FR 28118) for a complete discussion of how the Agency applies the "no migration" standards in deep injection wells.

This manual is not a comprehensive review of "no migration" variances, and will not provide the answers to all petitioners' questions; however, it does address the required scope of credible petitions. The EPA is strongly encouraging petitioners to meet with the Agency before preparing petitions to determine the scope and level of detail that will be required in individual petitions.

What is a "No Migration" Variance?

A "no migration" variance is a formal decision that can be rendered by the EPA to allow the land disposal at a particular facility of specific, prohibited wastes not meeting the treatment standards established by EPA. The statutory language requires anyone pursuing a "no migration" variance to demonstrate "to a reasonable degree of certainty that there will be "no migration" of hazardous constituents from the disposal unit or injection zone for as long as the waste remains hazardous." The EPA codified this language on November 7, 1986 (40 CFR 268.6). The EPA has interpreted the statutory language to mean that it must be demonstrated, to a reasonable degree of certainty, that hazardous constituents will not exceed Agency-approved human health-based levels (or environmentally protective levels, if they are appropriate) beyond the boundary of the disposal unit. In most cases, the disposal unit boundary is defined as the outermost limit of engineered components, but may be defined differently in some site-specific cases. **This definition of "no migration" does not allow fate and transport of hazardous constituents above acceptable health-based levels outside the boundary of the unit.**

What are the Land Disposal Prohibitions?

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA) authorizing EPA to establish nationwide standards for the management of hazardous wastes. Regulations promulgated under RCRA in Title 40 of the Code of Federal Regulations, Part 261 (40 CFR 261), include lists of designated hazardous wastes and methods for identifying wastes exhibiting hazardous characteristics. Under the Hazardous and Solid Waste Amendments of 1984 (HSWA), RCRA Sections 3004 (d), (e), and (g) were to include provisions prohibiting the land disposal of all such "listed" and "characteristically hazardous" wastes unless they meet technology-based treatment standards. In order to be land disposed, wastes included in the EPA's land disposal prohibitions will have to be treated by best demonstrated available technology (BDAT) to meet the treatment standard established by the EPA or meet the standard as generated, unless a "no migration" variance is obtained. Prohibited wastes cannot be stored on the land (unless storage is in containers or tanks and is for the purpose of accumulating sufficient quantities to facilitate proper recovery, treatment, or disposal) without a "no migration"

variance. The land disposal prohibitions become effective on the dates indicated below.

November 8, 1986	-	Solvents and Dioxins
July 8, 1987	-	California List*
August 8, 1988	-	At Least One-Third of All Other Listed Wastes
June 8, 1989	-	At Least Two-Thirds of All Other Listed Wastes
May 8, 1990	-	All Remaining Listed Wastes and All Characteristic Wastes

A complete schedule of the land disposal prohibitions can be found in 40 CFR 268.10 through 268.13. These prohibitions apply to all hazardous wastes identified under RCRA as of November 8, 1984. For hazardous wastes identified in 40 CFR 261 after that date, EPA must make prohibition determinations within 6 months of the date of listing or identification of the new hazardous wastes. Nevertheless, the statute does not impose an automatic prohibition on land disposal if EPA misses a deadline for any newly listed or identified waste.

Direct land disposal of an untreated waste that does not meet the BDAT treatment standard may be allowed nationally by EPA for up to 2 years if treatment capacity is inadequate. Effective dates have been extended by 2 years for many California List and First Third wastes. In addition, two 1-year case-by-case extensions of the effective dates of prohibitions may be granted under certain circumstances. The applicant must demonstrate that adequate capacity to treat, recover, or dispose the waste is not available by the effective date and that he has entered into a binding contractual commitment to provide such capacity. (EPA is developing a guidance document for case-by-case extensions.) All other RCRA hazardous wastes that do not meet the BDAT treatment standard will be banned from land disposal unless a "no migration" variance is received from the EPA.

* Based on regulations developed by the California Department of Health Services for hazardous waste land disposal restrictions in the State of California.

Who Can Receive a "No Migration" Variance?

A "no migration" variance petition can be submitted by anyone who temporarily stores or disposes of hazardous wastes in or on the land. The petition for a "no migration" variance can be submitted by any interested hazardous waste facility owner or operator, either individually or collectively. The petition must clearly demonstrate that the land-based storage or disposal method to be employed protects human health and the environment. This requires showing, to a reasonable degree of certainty, that hazardous constituents will not exceed human health-based levels (or environmentally protective levels, if they are more stringent) beyond the edge of the disposal unit. The petition must also provide long-term assurance that the "no migration" variance criteria will be met. (Of course, in the case of petitions for temporary placement, long-term assurances would not be necessary.) The variance only becomes effective after EPA reviews the petition, solicits public comments, and publishes a final determination in the Federal Register. In most cases, the variance will require monitoring to demonstrate continuing compliance (see substantive and procedural requirements in the Land Disposal Restrictions First Third Rule, August 17, 1988, 53 FR 31138).

In the November 7, 1986 Final Rule (51 FR 40572), the Agency identified several scenarios that may satisfy the "no migration" standard. These scenarios are not the only situations where "no migration" may be demonstrated successfully. The first is the placement of compatible non-volatile waste in a massive and stable geologic formation such as a salt dome. In this case, the Agency would expect the "no migration" demonstration to focus on the stability, extent, and homogeneity of the host formation, as well as potential for releases during placement.

The second scenario is the placement of a waste consisting of fairly immobile constituents in a monofill located in an arid area that has no ground-water recharge. The petitioner would need to demonstrate that hazardous constituents will not migrate out of the unit above health-based (or environmentally protective) levels. Such a demonstration may be successful due to the well-defined characteristics of the waste constituents in a monofill.

In the third scenario, a treatment facility renders the waste nonhazardous through active chemical, physical, or other processes. An example is the neutralization of a corrosive waste, which does not contain hazardous constituents above health-based levels, in a surface impoundment. This scenario is especially applicable to wastes that are considered hazardous due only to their ignitable, reactive, or corrosive characteristics.

In the fourth "no migration" scenario, hazardous waste is stored temporarily on the land for the purpose of accumulating sufficient quantities of the waste to allow for proper recovery, treatment, or disposal within the meaning of RCRA Section 3004(j). The waste is stored in a totally enclosed indoor waste pile with a floor or bottom liner, where engineered containment systems and air pollution controls are effective over the period the waste remains in storage. Inspections of the building are performed frequently to ensure that precipitation is not entering the unit. The waste pile is clean-closed at the end of the storage period.

Except for temporary storage operations, it should not be assumed that man-made barriers or engineered systems (e.g., liner systems) alone will meet the "no migration" standard. Although artificial barriers in conjunction with partial waste treatment or barriers that are expected to last substantially longer than the hazardous life of the waste may enhance a petition, artificial barriers alone cannot be relied upon to provide the long-term assurances required. For this reason, "no migration" variances generally are not envisioned for conventional land disposal units (e.g., landfills and surface impoundments). For temporary land-based storage purposes only, the containment of hazardous waste within engineered barriers (meeting minimum technology requirements) will be considered in making the "no migration" demonstration, provided that wastes are to be removed after a reasonably short storage period that may be conservatively projected to be well before the failure of the engineered barrier system.

An additional "no migration" scenario is the placement of hazardous waste (particularly that from petroleum refining) in a land treatment unit. Under carefully controlled conditions, the wastes are biodegraded in the treatment zone with no releases at concentrations constituting migration to any environmental media, including air. The owner/operator manages the land treatment unit so that

nondegradable hazardous constituents are not allowed to accumulate within the unit to levels exceeding health-based levels.

In addition, the Agency cautions potential petitioners that the burden of proof in demonstrating "no migration" will be substantially greater for facilities with a history of continuing mismanagement of hazardous waste and serious compliance problems, as evidenced by State or EPA monitoring and inspection reports. (Minor infractions in compliance should not affect EPA's review of a petition.) This does not mean such facilities will be required to meet a more stringent standard, but that more information and analysis may be necessary, both in the petition and during operation under the variance, to confirm to the Agency's satisfaction that migration is not occurring and will not occur in the future. For example, more frequent waste stream analysis, or even sampling by an independent party could be required under the terms of the variance.

Similarly, for a unit that has experienced releases (migration) in the past, the owner or operator petitioning for a variance will be under a greater burden of proof to demonstrate both: 1) that the same type of release will not occur in the future, and 2) that past and future releases can be separated. The second item could be particularly relevant for the ground water medium, for example, where contamination from the unit that has already been detected in ground water could continue to appear in monitoring wells after a variance has been granted. It would be difficult to prove whether the contamination was from a past or present release. Likewise, for a unit located in a waste management area where releases have occurred from other units, it also could be difficult to differentiate between releases, particularly if the other units contained the same hazardous constituents as the unit in question.

In either case, the owner or operator is discouraged from submitting a "no migration" petition unless he or she can conclusively demonstrate not only that future migration will not occur, but also that past releases detected through monitoring either are not from the unit for which a variance is sought, or that they will not obscure or interfere with the ability of monitoring devices to detect future releases. If there is uncertainty, the assumption will be that the release is from the unit in question, and the variance likely will be denied or, if already granted, revoked.

What is the Definition of the "Unit Boundary?"

For surface impoundments, landfills, and waste piles, the unit boundary (and consequently, the point of compliance (POC)) generally is defined by the outermost extent of the engineered barrier(s) that contain the waste. For example, in demonstrating "no migration" from a unit via ground water or subsurface soil, the unit boundary would consist of the outer liner present in a surface impoundment, landfill, or waste pile. In demonstrating "no migration" from the unit via surface water or surface soil, the exterior of any dikes, ditches, or berms present at the edge of the "hazardous waste management unit" constitute the point of compliance. In demonstrating "no migration" from the unit via the air pathway, the outer limit of any engineered barrier over the unit (roof, dome, etc.) would constitute the point of compliance.

While engineered barriers form a useful way to delineate the boundary of a hazardous waste management unit, the Agency recognizes that these engineered components do not always exist. For example, most units are not enclosed to protect from migration via air. In this case, the downwind edge of the unit at a height of 1.5 meters constitutes the point of compliance for demonstrating "no migration" via air. (A height of 1.5 m corresponds with a typical inhalation height and facilitates the application of standard modeling and monitoring methods).

In cases where units are unlined (e.g., a unit obtaining an exemption from liner requirements under Section 264.221 (b) or (d)), EPA will use best professional judgment to set the unit boundary. Land treatment units have a subsurface point of compliance at the base of the maximum treatment zone (not exceeding 5 feet in depth from the initial soil surface) or immediately outside of any liner that may exist. Finally, for some miscellaneous units such as those regulated under Subpart X, the unit boundary should be decided on a site-specific basis. In the case of geologic repositories, for example, EPA believes it is appropriate to give some credit for the encapsulating or confining formation. In all cases, however, the Agency will demarcate the unit boundary and point of compliance for demonstrating "no migration" via all media in a suitably stringent manner.

Although engineered barriers frequently are used to define the unit boundary, engineered barriers such as liners alone are inadequate to prevent migration of hazardous wastes from a land disposal unit. Except for temporary storage units, the "no migration" demonstration must rely upon other assurances to demonstrate "no migration" from the unit. Other assurances may include treatment, waste removal after temporary storage, and characteristics of the waste, unit, or environment.

How are Levels of Constituents Evaluated?

A successful "no migration" demonstration must show that actual or predicted concentrations of hazardous constituents or emission rates at the edge of the disposal unit do not exceed Agency-approved health-based levels or environmentally-based levels for ground water, surface water, soil, and air. If health-based criteria do not exist for a constituent, the applicant may propose his own health-based levels using the toxicity testing guidelines contained in 40 CFR Parts 797 and 798, and the Agency guidelines for assessing health risks (51 FR 33992, 34006, 34014, and 34028). If no health-based level can be determined for a constituent, that constituent must not exceed analytical detection limits. Use of analytical detection limits should be based on methodology prescribed in "Test Methods for Solid Waste, Physical/Chemical Methods" U.S. EPA Publication No. SW-846, Third Edition, with the lowest possible detection level indicated therein for each hazardous constituent. If health-based levels are below analytical detection limits for a constituent, the petitioner must demonstrate, using modeling, that the health-based levels will be met. Nevertheless, in any compliance monitoring required for the unit where health-based levels are below detection limits, meeting detection limits would constitute compliance with the demonstration. In calculating these concentrations, the petitioner should use site-specific data to evaluate how the hazardous constituents will be apportioned between media, where the constituents are released into several media. When site-specific data are not available, worst-case assumptions must be used.

In reviewing the petition, EPA will compare the calculated concentration of hazardous constituents to Agency-approved levels. For example, the Agency would compare the constituent concentrations in leachate to the Maximum Contaminant Levels (MCLs), or Ambient Water Quality Criteria (AWQC). MCLs and AWQCs receive first priority for use as allowable exposure levels, where they exist. If an MCL or an

AWQC is not available for a constituent, the appropriate health-based levels would be the Reference Dose (RfD) for noncarcinogens and the Risk Specific Dose (RSD) for carcinogenic compounds. These health-based criteria have been calculated by assuming chronic (lifetime) exposure by ingestion or inhalation of contaminated media. For carcinogens the maximum residual risk level is $1x10^{-6}$ Class A and B carcinogenic constituents, and 1×10^{-5} for Class C carcinogens.

For a "no migration" petition, it is necessary to evaluate the concentration of contaminants in air, surface water, and soil as well as in ground water. The Agency has published health-based levels for soil ingestion and inhalation for a subset of the hazardous constituents listed in Appendix VIII of 40 CFR 261. The interim draft RCRA Facility Investigation (RFI) Guidance (EPA 530/SW-89-031, February, 1989) contains tables of health-based criteria; both it and the interim draft Surface Impoundment Clean Closure Guidance, U.S. EPA, October, 1987 also have explanatory text on the assumptions used to calculate the numbers. More information on these health-based numbers is also available in the Superfund Public Health Evaluation Manual, U.S. EPA, 1986; and the Integrated Risk Information System (IRIS); U.S. EPA, 1988. IRIS is available through various on-line networks such as DIALCOM Inc., the Public Health Network, and the National Library of Medicine's TOXNET. Because all health-based numbers are subject to review and change, EPA recommends that the petitioner contact EPA's Characterization and Assessment Division in Washington, D.C., at (202) 382-4761 to obtain up-to-date information on health-based levels.

The Agency believes that human health-based exposure levels generally will be protective of both human health and the environment. Nevertheless, the Agency may determine that an exposure level for a constituent should be lowered from the human health-based standard in order to protect against detrimental environmental effects around the unit (e.g., those that may pose a threat to endangered species, or sensitive ecosystems). EPA will provide the opportunity for notice and comment on such an exposure level within the petition process.

In addition to comparing individual constituents to the appropriate health-based level, the Agency may also consider additivity in evaluating the risk posed by concentrations at the unit boundary. For example, if the petition identifies two constituents that appear at the unit boundary at levels which are below health-based limits for each of the constituents, the Agency also may consider the potential

threat posed by adding the two constituents. The Agency intends to consider additivity only for constituents in the same environmental medium (e.g., air). For more information on the EPA's policy on chemical mixtures, the petitioner should refer to the Guidelines for the Health Risk Assessment of Chemical Mixtures (51 FR 34014).

Petitioners for units in areas where background levels of a hazardous constituent exist should demonstrate that the incremental contributions of contaminants from their unit will not, in and of themselves, exceed health-based levels. For example, if the air inhalation health-based level for Substance X is 10 ppm, and background levels of that constituent are 5 ppm, "no migration" could be successfully demonstrated by projecting and monitoring concentrations at the unit boundary not exceeding 15 ppm. The net contribution of Substance X from the unit then would not exceed the health-based level of 10 ppm. In other words, high background levels of a hazardous constituent will not prevent the granting of a "no migration" variance; however, neither will they allow releases attributable to the unit that exceed health-based levels, regardless of how high background levels might be.

How Long is "As Long As the Wastes Remain Hazardous?"

This is a waste- and site-specific determination. For some waste types that degrade naturally to health-based levels in a relatively short time period, the petitioner may only have to demonstrate such degradation and show "no migration" from the unit during the degradation period. On the other hand, where nondegradable constituents such as metals will exist within the unit, the petitioner will potentially have to make the difficult demonstration that "no migration" will occur for many thousands of years, unless such constituents are removed at closure or the unit is capped with clean soil. (Capping will be acceptable only where there is not leaching potential as determined using a leachability test or modeling procedure that the Agency determines is valid for the particular types of hazardous constituents present.) Note that the UIC program considers a demonstration of "no migration" for 10,000 years to be sufficient, given the nature of wastes that are disposed of through underground injection.

What is the Relationship Between Land Treatment Units and "No Migration"?

Land treatment units are subject to all of the general provisions of the land disposal restrictions program, since they are considered to be disposal units under RCRA 3004(k). Thus, in order to apply prohibited wastes which do not meet the BDAT performance standards, an owner or operator of a land treatment unit must receive a "no migration" variance.

The petitioner for a land treatment unit must demonstrate that the "no migration" standard is met for all media. The land treatment demonstration (LTD) need not be complete in order to receive a "no migration" variance. The "no migration" variance will be granted based upon certain basic monitoring and modeling data. However, the variance will be conditioned upon completion of the LTD within a specified time period (usually two years after the date of granting of the "no migration" variance), or else the variance will be revoked. This requirement is intended to ensure completion of the Land Treatment Demonstration in a timely fashion, while nevertheless recognizing that the land treatment unit must operate in order to generate the relevant information and data. However, it should be clarified that this provision is not intended to effect any time extension of the requirement to have an approved "no migration" variance prior to land disposal of restricted hazardous waste. Land treatment units are required to have an approved "no migration" variance prior to receipt of restricted hazardous waste, regardless of whether or not the Land Treatment Demonstration is complete. Furthermore, petitioners with incomplete Land Treatment Demonstrations also must meet all of the same information requirements to fulfill "no migration" petition criteria.

Many wastes that are currently land-treated contain significant amounts of volatile constituents and/or metals. The petitioner must demonstrate a sufficient level of degradation and/or immobilization of waste constituents and metals within the treatment zone to assure that hazardous constituent concentrations will remain lower than human health-based or environmentally-based standards at the treatment zone/soil boundary. For land treatment units, the "disposal unit" consists of the treatment zone (plus the liner, if any exists). For volatile constituents, the applicant must demonstrate that the health-based or environmental levels are not exceeded at the downwind edge of the unit boundary at a height of 1.5 meters. This demonstration should be made by using site-verified emission and dispersion

models, emission monitoring and/or ambient air monitoring. In addition, an applicant may need to pretreat a volatile waste (e.g., air stripping with appropriate air pollution controls) in order to successfully demonstrate "no migration" of the contaminant to the air. (For more information on "no migration" demonstrations for the air medium, see the Appendix.) The applicant should attach all relevant parts of his land treatment demonstration permit application to the "no migration" petition, including biotoxicity studies, degradation studies, and general site information regarding ground water, surface water, climate, and soil.

If it has been completed, the LTD can be used as a basis upon which to build a "no migration" petition. However, the information that is typically provided in the LTD is largely current sampling and monitoring information. The petition must contain sufficient modeling and theoretical, long-term projections to insure that migration will not occur to any medium "for as long as the wastes remain hazardous." Because the LTD does not address the air medium, the air demonstration must also be added. Finally, if accumulations within the unit of nondegradable hazardous constituents exceed health-based levels for soil ingestion at the end of the post-closure period, a leachability test or modeling procedure that the Agency determines is valid for the particular types of constituents present must be performed to determine their leachability. Such tests may include soil column studies on zone of incorporation soils, or other methods approved by the Agency. Dependent on the results of this leachability test or procedure, the unit's post-closure plan must require either that the unit be capped with clean soil at the end of the post-closure care period (if nondegradable constituents are not leachable above health-based levels), or that hazardous constituents be removed, at the end of the post-closure care period, to below health-based levels (if nondegradable constituents are leachable above health-based levels). If health-based levels have not been achieved a vegetative cover, as required at Part 264.280(c)(2), must still be maintained during closure and post-closure, as well as on the clean soil cap. It should be noted that land treatment units (and other land disposal units), that will close with nondegradable hazardous constituents in place at concentrations above health-based levels must comply with 40 CFR Part 264.119(b) requirements for a deed notice that the site has been used for hazardous waste management. This provision is intended to prevent future human intrusion into the site after the post-closure care period has ended.

What is the Relationship between "No Migration" Variances, RCRA Permits, and Other Federal Laws?

"No migration" variances may be issued for units functioning under interim status, units with permits under RCRA, or for new units seeking Part B permits. Because much of the information that must be included in a RCRA Part B application must also accompany the petition for a "no migration" variance, facility owners and operators are encouraged to submit petitions with the relevant Part B data summarized, and copies of critical Part B materials attached as needed.

Under 40 CFR 268.6(a)(5), before being issued a "no migration" variance, the petitioner must provide EPA with sufficient information to assure the Administrator that land disposal of the prohibited waste(s) will comply with other applicable Federal laws. These may include the Clean Air Act, the Clean Water Act, the Safe Drinking Water Act, the Endangered Species Act, the National Historic Preservation Act, the Wild and Scenic Rivers Act, the Coastal Zone Management Act, the Fish and Wildlife Coordination Act, the Atomic Energy Act, and the Marine Protection, Research and Sanctuary Act. This also includes other provisions of RCRA, such as regulations under Section 3004(n) limiting volatile organic air emissions from TSDFs. The operation for which a variance is sought must also be in compliance with applicable State and local laws and ordinances.

Can Generic Petitions be Submitted Covering Several Similar Units or Facilities?

Yes, but generic petitions are likely to raise practical difficulties, and are discouraged in most cases. The usefulness of a generic petition is limited since petitions must include site- and waste-specific data. Accordingly, petitioners would have to demonstrate that each scenario covered under a generic petition is essentially the same. A demonstration that the hydrogeological characterization of each site would be essentially the same would require the detailed assessment of each site addressed in the petition; furthermore, it is unlikely that such a demonstration could actually be made. As a result, the Agency expects few, if any, generic petitions for land disposal units. An exception may be made for temporary storage units. For example, several identical indoor waste piles containing identical wastes at the same clean-up site could be covered under one petition. Even so, identical units at

different facilities likely would require different petitions because of variations in locational and environmental conditions.

When Does a Variance Become Effective and How Long Does it Last?

Variances will be effective only after issuance; submittal of a petition will not exempt a facility from complying with applicable land disposal prohibitions.

Variances will be valid for up to 10 years, but not longer than the term of the facility's RCRA permit. The variance will automatically expire upon termination or denial of a RCRA permit, or when the volume of waste for which the variance was issued is reached. EPA may revoke a unit's "no migration" variance if the Agency determines migration has occurred or that such a variance is no longer protective of human health or the environment. Owners and operators desiring to renew expired variances must re-petition the Agency. Petitions to renew must undergo the same notice and comment procedure as did the original petition.

Additional Requirements for No Migration Variances

Monitoring Plans for Land Disposal Units

40 CFR Sections 268.6(a)(4) and 268.6(c)(1) require that petitions include plans for continued monitoring of media of concern to verify compliance with the "no migration" demonstration. The monitoring plan must be designed to detect migration "at the earliest practicable time". The Agency intends this to mean at, or as near as possible to, the unit boundary. In certain limited cases the Agency may determine that monitoring of one or more media at an individual site is unnecessary, or technically infeasible or impractical. Monitoring of hazardous waste units and/or the waste stream going into the unit also may be required, unless unnecessary, or technically infeasible or impractical.

Reporting of changes in Operating Conditions From Those Described in the Variance Application

40 CFR 268.6(e)(1) and (2) require reporting of changes from conditions described in the variance application, including changes in the type of waste stream received,

operating practices, unit design and construction, or unusual and significant changes in the environment such as significant fluctuations in the water table or surface water flow. Where such a change is planned, such as for an operating practice, the owner or operator must notify the Agency in writing at least 30 days in advance for approval. Where the owner or operator discovers that there has been a significant and unplanned change from the conditions upon which the variance was granted, the owner or operator must notify the Agency within 10 days of discovery. EPA then will determine whether action is necessary; such action may include revocation of the variance or variance modifications.

Detection of Migration of Hazardous Constituents

The Agency has promulgated at 40 CFR 268.6(f) notification requirements if migration is detected. If an owner or operator discovers migration from the unit after a variance has been granted, the owner or operator must immediately stop receipt of the restricted waste and notify EPA within 10 days of discovery. EPA will then decide within 60 days whether the unit can continue to receive prohibited waste, or whether the variance will be terminated. If the Agency determines that migration is occurring or has occurred from the unit (i.e., that a release from the unit exceeds Agency-approved health-based or environmental-based exposure levels), the Agency shall revoke the variance. This approach is based upon the belief that, with the exception of the air medium, once even a single incidence of migration has occurred, the "no migration" demonstration has failed. For the air medium the Agency holds a slightly different interpretation, however, based upon an annual average air concentration to demonstrate that "no migration" is occurring from the unit. EPA interprets migration to the air medium as exceeding the health-based level for a hazardous constituent on an annual average basis, not on a single event. The Agency believes this approach is consistent with the approaches to long-term ambient air standards under the Clean Air Act, and that it is also protective, since health-based levels are based upon long-term exposure assumptions, and are not appropriate for use in an acute air exposure scenario. Furthermore, air concentrations are highly dependent upon dispersive and temporal factors, and therefore differ from the ground water, surface water, and soil media, where these factors are less significant. Furthermore, the Agency will revoke a unit's "no migration" variance if, on the basis of any information, the Agency at any time

determines that migration from the unit has occurred, or that such a variance is no longer protective of human health and the environment.

Substantive requirements for variances for waste disposal in deep injection wells may differ slightly from those described above. The reader should refer to the July 26, 1988 rule (53 FR 28118) for more detailed information on injection wells.

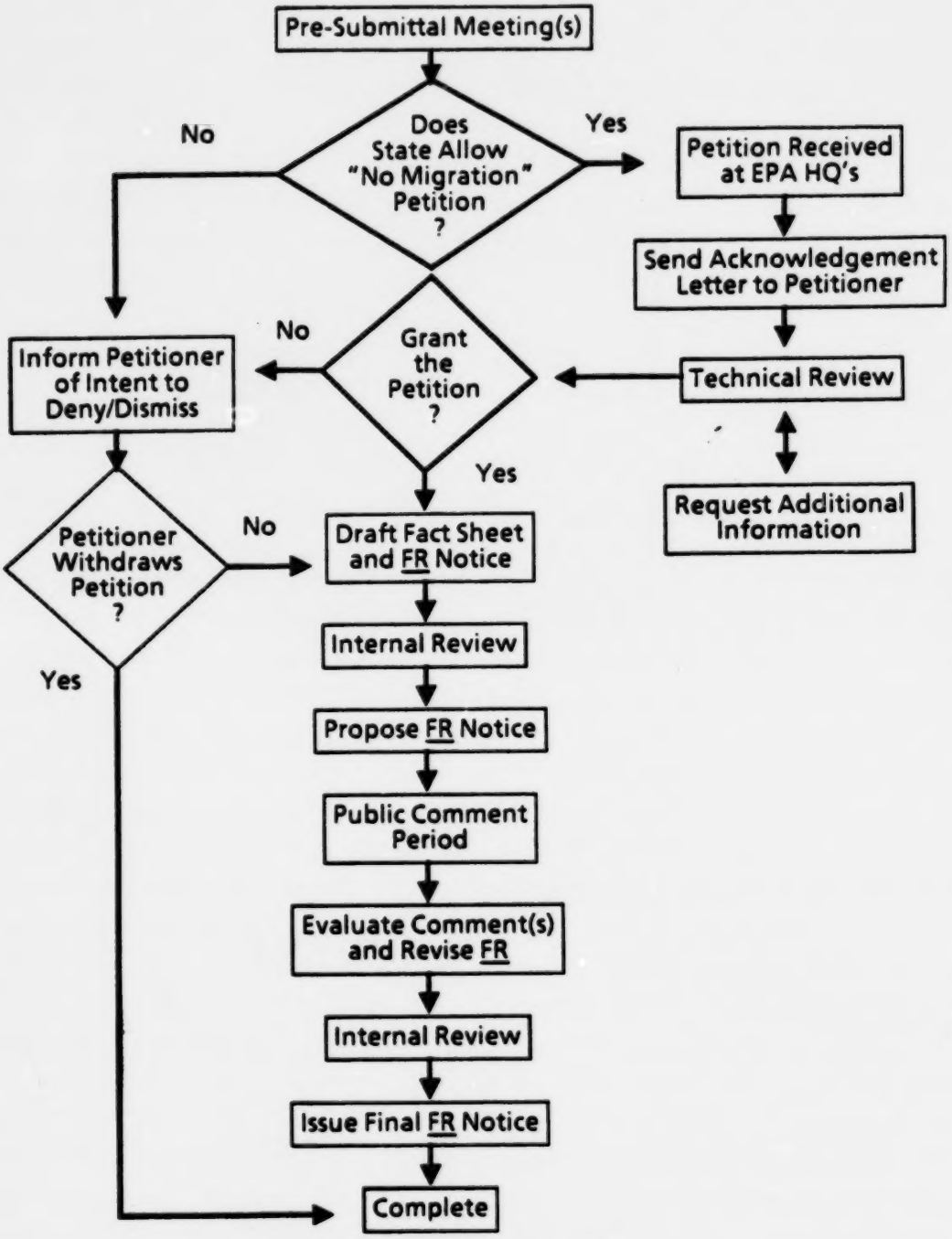
What is the Petitioning Procedure for "No Migration" Variances?

Outlined below is a step-by-step process for the submittal and review of "no migration" petitions, illustrated in the figure on the following page. Until States have been authorized for the land disposal restrictions and "no migration" variances, EPA is requiring that applicants submit petitions to the EPA Administrator. Petitioners should note that State programs are free to impose disposal prohibitions if such actions are more stringent or broader in scope than Federal programs (RCRA Section 3009 and 40 CFR 271.1(i)). Where States impose bans which contravene an EPA action, such as not allowing provisions for granting a "no migration" petition, the more stringent State standard shall apply and the petition will not be reviewed by EPA.

It should be noted that the petition submittal and review process discussed in this guidance manual does not apply to "No Migration" petitions for underground injection wells.

Pre-Submittal

A very important component to the "no migration" process is the pre-submittal meeting between the petitioner and the EPA. This meeting is critical in ensuring expeditious decisions on petitions. The purpose of the pre-submittal meeting is to provide the petitioner with an opportunity to identify the hazardous waste, hazardous constituents, and disposal unit(s) to be included in the petition. The EPA can provide some historical background on the review of similar petitions, including a tentative timeframe for the review process. The Agency also recommends that petitioners submit a preliminary outline of their petition for Agency review.



"No Migration" Petition Review Process

Petition Submittal

As required by Sections 268.6(c) & (d) of the regulations, each petition must be submitted to the EPA Administrator and include the following statement signed by the petitioner or an authorized representative:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in this petition and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Six copies of the petition should be sent to:

> Chief, Assistance Branch
> Office of Solid Waste
> U.S. Environmental Protection Agency
> 401 M Street, S.W. (OS-343)
> Washington, D.C. 20460

(When a State becomes authorized for the land disposal restrictions and "no migration" variances, petitions for units within that State should be sent to the State for review and determination.)

Once the petition has been received by the EPA, a public docket will be established for the petition and a person from the Assistance Branch (the reviewer) will be assigned to the petition. The reviewer will send a letter to the petitioner acknowledging receipt of the petition. This letter may also contain a tentative timeframe for the review of the petition. Copies of this letter will be distributed to the appropriate EPA Regional Office and State Agency.

Petition Review

Petitions will be reviewed by EPA Headquarters with assistance from Regional and State personnel. The reviewers will perform an initial review of the petition. Once this initial review is completed, EPA will decide if additional information is needed to make a decision on the petition. If additional information is needed, a letter requesting the information will be sent to the petitioner. Information to aid in the

review may also be requested from the State contact. The request letter to the petitioner will contain a deadline for the submittal of the additional information. This deadline will be dependent on the type of information being requested. Nevertheless, the deadline will not exceed a period of 180 days from the date of the request letter. Once the reviewers have obtained all of the necessary information for the review, a comprehensive, technical review will be performed. As part of this review, the reviewers will work closely with the State contact and will normally perform a site visit.

If the additional information is not received by the deadline, or a request for an extension of the deadline is not submitted, the reviewers may recommend that the petition be dismissed. The Agency plans to dismiss incomplete petitions by letter. A dismissal letter will be sent to the petitioner and to the appropriate State and EPA regional contacts. The effect of a dismissal is to remove the petition from the review process and close the petition file. The petitioner may at any time re-submit a complete petition.

Decision to Grant or Deny

Once the technical review is complete, EPA will reach a tentative decision to grant or deny the petition. If the tentative decision is to grant the petition, the Agency will publish a Federal Register notice describing its intent. If the tentative decision is to deny the petition, the petitioner will be informed by letter of the intent to deny. This letter will also offer the petitioner the opportunity to withdraw the petition. If the petitioner declines to withdraw the petition, the Agency will publish a Federal Register notice describing its intent to deny the petition. At this point, with both petitions intended to deny and to grant, there will be opportunity for public comment. The final decision subsequently will be published in the Federal Register.

What Information Should be Included in a "No Migration" Petition?

"No migration" petitions will vary considerably. The petition content will be strongly influenced by the type of facility for which a variance is sought and the methods chosen to demonstrate that migration will not occur. Certain types of units may have relatively simple information requirements because of the simple nature of their "no migration" demonstration (e.g., some temporary storage units); other

types of units for which complex demonstrations are made will necessarily require more complex characterization and detail. The petitioner must provide site-specific information and may, additionally, provide generic and national information for certain requirements. The descriptions of petition content provided on the following pages are intended to illustrate the nature and complexity of the information that may be required.

This manual should be used as a starting point for identifying the kind of information that will be required for each element of the petition. In some cases, information identified in this manual may not be necessary; in other cases, additional information will be required. Identification of the specific information needs for a given unit can best be accomplished in pre-petition conferences between the Agency and facility owners and operators.

Discussions of each of the principal petition components listed can be found in the following pages. (It should be noted, however, that the information components described below generally apply to long-term land disposal. For temporary placement, some of the items might not be relevant.) A detailed checklist of possible petition requirements is presented at the end of this manual.

Often, much of the information required for a "no migration" petition will already have been submitted in the petitioner's Part B permit application. Such information need not always be duplicated in the "no migration" petition, but in some cases simply may be summarized and referenced therein. However, the petitioner is encouraged to duplicate and include critical components of the petition in order to expedite its review and processing.

Waste Descriptions

"No migration" variances are available only for the disposal of specific wastes at specific units. Variances are not available for broad categories of wastes; they are issued only for those wastes for which compliance with the "no migration" standard is demonstrated in the petition. Proper management of wastes for as long as they remain hazardous requires that potential incompatibilities and waste transformation mechanisms be assessed.

Hazardous and nonhazardous wastes may interact causing changes in their toxicity and/or mobility. Therefore, it is important that the applicant individually characterize, to the extent possible, each waste to be placed in the unit, including wastes not subject to the land disposal ban.

Waste descriptions should be properly documented and in compliance with appropriate quality control and quality assurance guidelines. The following is a breakdown of the information that generally should be provided on each petitioned waste.

Waste Types and Sources --

Background information generally should be provided on each waste to be covered by the variance. Such information includes the applicable waste codes (EPA and industrial), the waste-generating processes, the hazardous constituents and their properties, the quantities of waste to be placed in the unit and the rates of placement, and handling and storage practices.

Waste Characteristics --

Physical and chemical characterization is required for each petitioned waste and other wastes to be placed in the unit. The potential for leachate formation, waste solubilities, hazardous-constituent vapor pressures, and other factors that could affect waste mobility should also be assessed. Analytical information should include results of testing for Appendix VIII constituents reasonably expected to be present in the waste. Where release to groundwater is a concern, the petition should provide leachability study test results to determine the leachability of contaminants, simulation models of leachability and transport, and field leachate analyses, if available. Acceptable procedures for waste sampling and analysis can be found in the EPA publication Test Methods for Evaluating Solid Waste.

Waste Incompatibilities --

The codisposal of incompatible wastes can result in the generation of heat, the production of flammable and toxic gases, and the solubilization and mobilization of hazardous constituents. A comprehensive assessment of waste compatibilities

would include all potential chemical interactions, reaction products, and product characteristics. The applicant should document, to the extent practicable, any waste incompatibilities and reaction products.

Waste Transformation Mechanisms --

To properly demonstrate that wastes can be contained in the unit, the applicant may be able to show that wastes change over time, resulting in nonhazardous degradation products. In addition, it may be necessary to characterize the mechanisms by which the wastes change over time. Waste transformations may alter waste mobility and/or toxicity and should be predicted to properly determine the resulting concentrations of hazardous constituents at the unit boundary. In any case, reaction rates and products should generally be characterized and product characteristics for each transformation mechanism should be provided. The petitioner may also be called upon to characterize combinations of transformation mechanisms. An assessment of the stability of the waste matrix, matrix characteristics, and the effect of all transformation mechanisms on the matrix should be provided. The mechanisms that generally should be accounted for in a "no migration" demonstration are as follows:

Biodegradation. The breakdown of a compound by microbial attack, may be very important for organic compounds. Degradation rates are dependent on environmental conditions (pH, salinity, dissolved oxygen, nutrients), the concentrations of waste and microbes, and the types of microbes.

Photodegradation. A chemical change in a compound resulting from absorption of ultraviolet light, must be considered where appropriate. Tests to determine the photodegradation rates should control for pH, light wavelength, light intensity, competing reactions, temperature, and waste concentrations.

Hydrolysis. The degradation of a chemical compound upon reaction with water, may be a significant transformation mechanism for some wastes.

Oxidation/reduction. The transfer of electrons between molecules, is a common degradation mechanism.

Volatilization. Although technically not a *transformation* mechanism, is the conversion of a solid or liquid material into a vapor state. It may represent a significant waste *transport* mechanism (i.e., from one medium to another). Determination of environmental factors affecting volatilization rates (e.g., temperature, pressure, vapor pressure, solubility) may also be required.

The likelihood of these and other waste transformation mechanisms should be described in the petition. The methods by which petitioners determine transformation rates, whether actual waste data or theoretical calculations, also should be thoroughly described. The actual testing of waste transformation processes or the use of accepted procedures for transformation rate determination may be required.

Facility Description

The petition should include a description of the hazardous-waste management facility where the waste will be disposed in sufficient detail to familiarize the reviewer with its overall operation. The facility name, mailing address, and location should be provided, together with information on a point of contact for correspondence concerning the petition. The nature of the facility's business should be identified and, for onsite facilities, the processes involved in the generation of hazardous wastes should be described. Operators of facilities accepting waste from off-site should identify the types of industries serviced.

Detailed design, layout, and operating plans should be provided for the unit covered by the petition. Unit descriptions should focus on waste isolation capabilities of the unit or environmental setting. In many cases, the type of information and level of detail will be similar to those included in RCRA Part B permit applications. (Detailed guidance concerning Part B applications for land disposal units can be found in the EPA's 1984 Permit Applicants' Guidance Manual for Hazardous Waste Land Treatment, Storage and Disposal Facilities.)

Although man-made barriers and engineered systems alone cannot be relied upon to provide the long-term "no migration" assurances required, they may play a role in the facility operation. The exception is certain temporary storage facilities that may

rely entirely upon engineered systems to isolate wastes. For temporary land-based storage purposes only, the containment of hazardous waste within engineered barriers (and meeting Part 264 requirements) will be considered in making the "no migration" demonstration, provided that wastes are to be removed after a reasonably short storage period that may be conservatively projected to be well before the failure of the engineered barrier system. All barriers should be thoroughly described.

The unit boundaries, which will serve as the compliance point for the variance, should be defined and thoroughly described. In the case where there is no engineered boundary above the waste to control air emissions, the downwind edge of the unit at a height of 1.5 meters will be the point of compliance for air emissions.

Other aspects of facility design and operation may be considered in evaluating the petition, including:

Procedures employed to prevent hazards
Contingency plans
Personnel training plans
Closure plans
Post-closure plans

These elements of the facility description are also common to Part B applications. Any relevant Part B information should be summarized in the petition, or attached as necessary.

Site Characterization

A thorough description of each facility's natural environmental setting is crucial to a "no migration" demonstration in any case where permanent disposal is contemplated. The site's climatology, meteorology, geology, and hydrology must be described in sufficient detail to permit assessment of the degree of waste isolation achievable. Environmental factors and long-term environmental changes that may impact the waste isolation potential of the unit should be addressed. Moreover, background ground water, surface water, soil, and air quality must be determined to properly assess any potential impacts of land disposal. The information that may be

required is similar to the requirements for a Part B permit application and a RCRA Facility Investigation (RFI). (Detailed guidance concerning RFIs can be found in EPA's 1989 interim final RCRA Facility Investigation Guidance Manual.)

Even so, because a "no migration" demonstration does not allow for consideration of fate and transport of hazardous constituents above acceptable levels outside the unit boundary, the focus of site characterization should be on the potential impacts of the site on the waste to be isolated in the unit. For example, the potential impacts of wind, rainfall, and the fluctuation in the ground-water table on the unit and the waste within it should be addressed. Nonetheless, while the demonstration cannot involve consideration of fate and transport of constituents outside the unit, locational and environmental factors that are external to the unit may have significant bearing on the probability of migration from the unit occurring. Therefore, information on particularly sensitive or vulnerable site characteristics may be useful in determining the degree of certainty required in a "no migration" demonstration.

Geology --

A geologic description should include regional, local, and site information. A discussion of regional and local geology should include the following components and contain maps and other supporting documentation:

Structure. Density, distribution, and orientation of faults, folds, and fractures

Subsurface Geology. Identification, lithologic descriptions, and thicknesses of all geologic formations underlying the region; available geophysical surveys, well logs, and boring logs

Geomorphology. Discussion of present surface features, processes that could affect surface features, and subsurface features that may be implied

Geologic Stability. Potential for earthquakes and degree of resulting ground motion, faulting, landslides, subsidence, creep, and other types of earth movement

The discussion of local geology should also include soils and topography. Where relevant, the soils information should encompass soil types (Unified Soil Classification System), properties, thicknesses, and depths to bedrock. In addition, similar site-specific geologic information should be provided, whenever possible.

Ground-Water Hydrology --

The petition should include a comprehensive description of regional, local, and site ground-water hydrology. Ground water is particularly vulnerable to contamination with hazardous constituents from land disposal units and, in many cases, can provide an avenue for waste constituent transport to surface waters and municipal and private wells as well as provide a subsurface migration pathway for gases. In some instances ground water may migrate into a unit, mobilizing contaminants out of the unit. The following types of information, including maps and supporting documentation, may be required for a "no migration" petition:

Identity and lateral extent of all aquifers, confining layers, and perched water tables

Characteristics of all necessary aquifers and confining layers, including thickness, porosity, permeability, hydraulic conductivity, and storage

Ground-water elevations and seasonal variations thereof

Existence of aquifer interconnections

Ground-water flow rates, directions, and recharge and discharge areas

Locations of all local municipal and private wells and surface water discharge areas. (For temporary storage in enclosed waste piles, and perhaps other cases where groundwater is of limited relevance, groundwater information may not be necessary, or the level of detail may be less.)

Surface-Water Hydrology --

A discussion of surface-water hydrology should include identification of all watersheds within the region that could potentially affect the facility. Maps of regional and facility drainage and the effects of facility run-on and run-off controls should be provided. Floodplain maps incorporating appropriate flood frequency data should also be provided. It must be clearly demonstrated that waste isolation will not be adversely affected by floods with a reasonable probability of occurrence during the period in which the wastes are hazardous (e.g., 25-year floods, 100-year floods, etc.).

Climatology and Meteorology --

Meteorological and climatological information should be sufficient to allow for the assessment of impacts of these factors on the disposal unit and site. The climate and meteorology of the site can have significant impact on the rate of emissions to air, for example. The following types of information may be required:

Site wind roses
Data on precipitation, temperature, and relative humidity data (seasonal maximums and minimums)
Maps of severe storm tracks and statistics on storm occurrence
Data on depth of seasonal freezing

Facilities relying in part on climatic factors to control waste migration (e.g., arid regions with no ground-water recharge) will be required to submit considerably more meterological and climatic information than facilities that are not significantly affected by climatic changes.

Background Environmental Quality --

The RCRA regulations specifically require that "no migration" petitions contain analyses of background air, soil, and water quality. The analyses and levels of detail should be site-specific. Those petitioners with facilities in sensitive environments will be required to submit considerably more background data than other petitioners.

Monitoring Plans

Monitoring of environmental media at land disposal sites is necessary to confirm that "no migration" of hazardous constituents beyond the unit boundary occurs (unless the Agency determines that monitoring of one or more media at a specific site is unnecessary or technically infeasible or impracticable.) Accordingly, the Land Disposal Restrictions First Third Rule [53 FR 31189, August 17, 1988] amended 40 CFR 268.6 to require that "no migration" petitions include a plan for monitoring at the unit boundary, to include the following information:

Media to be monitored
Type of monitoring to be conducted at the unit
Location of the monitoring stations
Frequency of monitoring at each station
The specific hazardous constituents to be monitored
An implementation schedule for the monitoring program
Equipment to be used at the monitoring station
Sampling and analytical techniques to be employed
Data recording/reporting procedures

The petitioner should provide sufficient information to justify the design of the monitoring program and to demonstrate that monitoring stations will be located to detect migration from the unit at the earliest practicable time.

For existing units that are receiving waste prior to "no migration" petition submittal, monitoring data for ground water, surface water, soil, and air will be required as part of the petition. The Agency recognizes, however, that monitoring data may be difficult or impossible to collect, or may be nonexistent, for new units. In these cases (as well as for existing units), variance approval will be conditioned upon Agency review and approval of monitoring data, gathered at regular intevals subsequent to unit operation, which confirms "no migration". (Nevertheless, where any monitoring data are available for a new unit, as a result of field test plots, etc., such data may be required as part of a "no migration" petition).

In most cases, in addition to initial monitoring to demonstrate "no migration", detection monitoring to confirm "no migration" for each medium will be required at regular intervals (for example, semiannually for ground-water monitoring to coincide with Part 264 Subpart F monitoring). However, for the air medium EPA is

taking a slightly different monitoring approach. Except for those units where the Agency has determined that air monitoring is unnecessary because there is no realistic probability of migration to the air medium, petitioners generally should conduct a one-time, reasonable worst-case ambient monitoring program to confirm that modeling estimates are reasonably accurate for the unit in question. (Monitoring under reasonable worst-case conditions is proposed, because it would facilitate detection of hazardous constituents, which may be at low concentrations near detection limits.) Subsequent to granting of the variance, however, rather than performing regular ambient monitoring during the operation of the unit, the owner or operator should regularly sample the waste stream entering the unit to confirm that the modeled annual quantity of a hazardous constituent is not exceeded. The Agency believes this approach will be appropriate because ambient air monitoring performed at the unit boundary may involve too many uncertainties and too much variability to be reliable in detecting migration. More information on air modeling and monitoring for the "no migration" demonstration is available in the Appendix to this guidance document. (Where a unit is covered or contained, and monitoring is at a specific point of release, however, routine monitoring may be appropriate.)

Monitoring immediately at the unit boundary may be difficult in certain locations or under unusual physical conditions at the site. Under such circumstances, the petitioner should propose a monitoring plan to be conducted as near as possible to the unit boundary without compromising the integrity of the unit. One such case may be hazardous waste repositories in geologic formations that are so extensive that installation of monitoring wells around the formation itself may not allow detection of migration at the earliest time, and installation of monitoring wells in the formation may damage the integrity of the formation. Monitoring of the repository itself (e.g., pressure monitoring of fluids between well casings in solution-mined caverns, or leachate sumps and pumps in room-and-pillar mines) may be suitable in this case. After repository closure, however, such monitoring may no longer be feasible. In certain situations, the Agency may determine that conventional monitoring of one more media at the unit boundary is technically infeasible or impractical. In most cases of technical infeasibility or impracticality, however, the Agency still will require some type of monitoring or modified monitoring as near as possible to the unit boundary without compromising the integrity of the unit.

In other cases, monitoring of all environmental media at a particular facility may be unnecessary. In certain limited cases the Agency may determine, based upon waste- and site- specific characteristics, that monitoring of one or more media is unnecessary at an individual site, because migration to that medium (those media) clearly is not a realistic concern. An example of this might be monitoring of air outside a totally enclosed treatment facility. In such a case, petitioners should include information that clearly demonstrates why monitoring of any medium is unnecessary. The Agency may then determine on a site-specific basis to waive monitoring requirements for one or more media. Petitioners who believe that one of these situations applies to their units should include in their petitions information that clearly demonstrates why monitoring of any medium is unnecessary or technically infeasible.

In addition to monitoring at the unit boundary, the petition in some cases should also include a plan for monitoring the wastes in the unit to detect any changes in waste composition which could affect the potential for migration of hazardous constituents over time. Such monitoring might include periodic testing of the waste in the units or leachate collection systems in surface impoundments, landfills, and room-and-pillar mines.

A petitioner may be able to incorporate all or part of a monitoring plan designed to comply with 40 CFR 264 or 265 Subpart F requirements into the "no migration" monitoring plan. For example, a petitioner may be able to use Subpart F monitoring wells if they will detect migration at the earliest practicable time, and may only have to modify the frequency or timing of monitoring. Nevertheless, the petitioner should be aware that "no migration" monitoring is different from Subpart F monitoring in that it is to be performed immediately at, or as close as possible to, the unit boundary. (See the Land Disposal Restrictions First Third Rule promulgated on August 17, 1988 (53 FR 31138)). Subpart F ground-water monitoring, on the other hand, does not necessarily occur at the unit boundary, but may instead occur at the edge of the waste management area. Furthermore, although Subpart F detection monitoring for indicator parameters may be helpful to demonstrate "no migration", "no migration" monitoring should be for a set of constituents determined based on a unit-specific analysis of the waste. While indicator parameters may still be suitable for "no migration" monitoring purposes, they may differ from those of Subpart F monitoring.

Waste Mobility Modeling

Accurate and representative modeling of waste constituent mobility may be required for the environment within the unit including unit liners and engineered barriers. The Agency also may determine in certain limited situations that modeling of a particular medium is unnecessary or infeasible (e.g., air modeling for a covered waste pile). However, where an engineered control such as a cover exists which greatly reduces the likelihood of migration to the air medium, but for which modeling is infeasible, the Agency may require the petitioner to assess the performance of the engineered system in lieu of modeling. Presented below is a brief overview of information requirements for modeling as well as considerations relevant to the choice of a representative model.

Several types of models may be used to predict waste mobility within the confines of the unit for which a variance is sought. Although hazardous constituents must not exceed human health-based levels beyond the engineered boundary of the unit, waste migration within the unit will be acceptable. Models may be developed for predicting leachate and gas generation rates, barrier integrity over time, and many other factors that can affect waste mobility. All such models and the assumptions underlying them must be thoroughly explained, and descriptions of the calculations and codes employed must be provided. Model assumptions and input data should be conservative and tend toward overestimating rather than underestimating migration. Models, input data, and relevant documentation should be available to EPA upon request and without restriction.

Modeling of waste and leachate migration in the unsaturated zone may be required for some units (e.g., the treatment zone of a land treatment unit). Waste constituent transport within that zone depends on site geology, soils, and climatology, as well as the physical and chemical characteristics of the waste and leachate. The factors affecting flow at or near the land surface are precipitation, run-off/run-on, evaporation, and transpiration.

Physical properties of the site soils that affect flow in the unit and the unsaturated zone that should be described in the petition include:

Water content
Pressure potential
Permeability
Degree of water saturation
Bulk density
Particle density
Water capacity
Hydraulic conductivity
Water diffusivity

The waste or leachate in the unsaturated zone can be affected by various chemical processes, including ion exchange, adsorption, precipitation, dissolution, and complex formation. Those processes appropriate to the waste and its leachates should be considered. Moreover, certain properties of the soil can be affected by the waste or leachate: its hydraulic conductivity can be changed; its permeability can be increased by the removal of organic matter or a change in adsorptive properties; and others of its properties can be altered by the dewatering of clays or a change in pore size. Flow patterns within the soil can also be altered by changes in pore size due to the dissolution and precipitation of chemical species. The impact of these factors should be taken into account in the model.

The potential for air emission of hazardous constituents from the waste surface into the atmosphere must be addressed. Emission rates are influenced by environmental as well as chemical and physical factors. The principal environmental factors influencing air emissions are temperature, soil characteristics (e.g., pH, moisture, grain size), and precipitation. The waste or leachate properties that should generally be modeled include vapor pressure, solubility, chemical activity, partitioning behavior of the solute (waste) between the atmosphere and water (Henry's Law), diffusivity, absorption, and release rate. (In some cases, such as covered or closed units, actual data on emission rates may be more appropriate than modeling.)

Limitations of any air emission release rate and dispersion models should be documented. The applicant should combine the use of models with ambient air and emission monitoring to characterize conditions at the unit to the greatest extent

possible. Any models used should be verified at the site. (For more information on the "no migration" demonstration methodology air, see the Appendix).

Appropriate models should be chosen for each of the waste mobility cases discussed (i.e., unsaturated zone, air, etc.). The choice depends on the objectives of the study and on the sensitivity of the model to various chemical and physical processes. The model chosen should be sensitive to all of the significant processes and, of the models considered, should be the most sensitive to those processes of greatest importance.

Other concerns in choosing a model are how well it represents the field situation, whether it is appropriate for the available data, and whether it can be confirmed for accuracy by comparison to actual measurements. The most sophisticated models may be inappropriate for the available data.

The petitioner should provide the following quality assurance and quality control information for every model used:

Model Confirmation and Calibration. Comparing the results of analytical and numerical models or matching field data to the model results is critical to model confirmation. Models should be calibrated at the site.

Justification of assumptions. Proper justification of all assumptions should be provided. Reasonably conservative assumptions should be chosen.

Sensitivity tests. An assessment of the influence of changes in the magnitude of model parameters should be provided. Models should show greatest sensitivity to the most influential processes.

Model accuracy assessment. It should be demonstrated that: (1) the model reasonably represents the actual physical system, (2) there are no computational errors in the computer code, and (3) there is a high degree of correlation between the model and measured data.

The EPA discourages the use of proprietary models, since the models selected will have to be closely scrutinized to determine their reasonableness and accuracy. They

also will be subject to public comment. The Agency will give most weight to data developed under appropriate QA/QC procedures, as described in the facility QA/QC plan, in the petition review.

Assessment of Environmental Impacts

In a "no migration" demonstration the petitioner must show that hazardous constituents do not exceed human health-based levels at the edge of the disposal unit. If lower levels must be met to protect the environment, then those levels will be required. For example, lower levels may be needed where there is potential impact to a sensitive environment (e.g., an adjacent wetland) or an endangered species even if human health- based levels are met. The petition should identify such environments or species for which there exists the reasonable probability of impacts from the unit for which a variance is sought. The assessment of environmental impacts does not mean that migration of hazardous constituents will be measured (or allowed) beyond the boundary of the unit. Such an assessment should be undertaken merely to determine if human health-based levels measured at the unit boundary are sufficient to protect any sensitive environmental receptors.

Environmental assessments should identify any factor which may reasonably be assumed to require stricter contaminant levels. This will involve defining the terrestrial and aquatic species that may be exposed to contaminants and the exposure pathways through which the species may be sensitive (e.g., inhalation, direct contact). Where exposure is possible, acute and chronic toxicity and bioaccumulation factors should be provided for each constituent with respect to the species involved. Effects of transported and transformed air pollutants (e.g., ambient ozone or photochemical oxidants) on agricultural crops, forests, or materials should be considered by the applicant. Field studies and biomonitoring may be performed in the absence of data, or available data for chemical analogs may be substituted.

Environmental considerations may include but are not limited to evaluation of:

Species diversity and abundance potentially affected by migration from the unit

Bioaccumulation potential in plants and animals

Fishery and habitat impacts

Endangered species of flora and fauna potentially affected by migration from the unit

Biological community structure alteration potential

It is important to note that, for many chemicals, exposure levels deemed safe for humans often have adverse effects upon terrestrial and aquatic life. In addition, toxicants present at low levels in the environment may bioaccumulate, presenting significant health risks to man and animals higher in the food chain.

Prediction of Infrequent Events

Under 40 CFR 268.6(b)(5) an analysis must be performed to identify and quantify any aspects of the demonstration that contribute significantly to uncertainty.

The petitioner must identify and evaluate the impacts of predictable future events that could contribute to or result in inadequate waste isolation. Natural phenomena that might require consideration include:

Earthquakes and resulting ground motion
Floods and droughts
Severe storm events
Climatic fluctuations
Geologic activity

The potential for such natural events during the period in which the wastes remain hazardous should be determined. Potential impacts and consequences of events with a reasonable probability of occurring during that period should then be estimated with respect to the facility's ability to isolate wastes from the environment. In addition, likely human-induced events which may affect the isolation capability of the unit, such as disturbance of the hydrologic regime and future land uses, should generally be considered.

Analyses of predictable events should take into consideration both the disposal unit and the surrounding environment. For example, ground motion resulting from an earthquake may cause the breaching of a unit, the fracturing of surrounding rocks, and surges in the ground-water level. Previously unconsidered avenues for contaminant migration may be created by the earthquake. Impacts of other geological activity such as sinkhole formation in areas of karst terrane or slope failure in areas of landslide susceptibility also should considered. In analyzing the potential consequences of predictable phenomena, probable worst-case scenarios should be used to ensure that any errors occur on the side of safety.

Quality Assurance and Control

Under 40 CFR 268.6(b)(4) a QA/QC plan that addresses all aspects of the petition demonstration must be included in the petition submittal and approved by the Agency. Quality goals and methods to assure that these goals are achieved should be included for each of the following aspects of the petition demonstration:

Waste and environmental monitoring, sampling, and analysis activities

Field measurements of the facility setting, such as geophysical exploration, ground-water monitoring, weather observations, and topographic mapping

Validation of computations, codes, models, and methods used in calculating critical facility parameters

Control of construction activities to ensure compliance with design specifications, where relevant to the "no migration" demonstration.

Evaluation of the integrity of construction materials, where relevant to the "no migration" demonstration."

The QA/QC plan generally should identify goals for each of the following quality indicators and describe how they will be achieved:

Data representativeness. The degree to which data accurately and precisely represent a characteristic of a population, a parameter, variations at a sampling point, or environmental conditions.

Data accuracy. The degree to which data agree with an accepted reference or true value. The measurement of accuracy exposes any bias in a system or method.

Data precision. A measure of the mutual agreement between comparable data gathered or developed under similar conditions. Precision is best expressed in terms of a standard deviation.

Data completeness. A measure of the amount of valid data obtained against the amount that was expected.

EPA will give most weight to data developed under appropriate QA/QC procedures, as described in the facility QA/QC plan, in the petition review.

CHECKLIST OF INFORMATION NEEDS

The following checklist is a comprehensive, but not all-inclusive, list of information needs. Individual petitions may require more or less information than that presented below. The level of detail required will depend on site-specific factors.

Facility Description

- ☐ Name of facility
- ☐ Address of facility
- ☐ Name of owner/operator
- ☐ Anticipated period of operation
- ☐ Status of RCRA permit application
- ☐ Location map
- ☐ Detailed site plan
- ☐ Aerial surveys
- ☐ Advantages/disadvantages of location
- ☐ Evaluation of storage/disposal unit
  - ☐ Design objective
  - ☐ Design criteria
  - ☐ Design performance projection
  - ☐ Materials specifications
  - ☐ Detailed drawings and specifications
  - ☐ Documentation of unit construction
  - ☐ Documentation of unit operation
- ☐ Closure plans
- ☐ Post-closure plans
- ☐ Cover design
- ☐ Design QA/QC demonstration (testing & inspection)
- ☐ Facility operation QA/QC demonstration

Waste Characteristics

- ☐ Waste type by name
- ☐ Processes that produced the waste
- ☐ Hazardous properties
- ☐ Physical characteristics
- ☐ Chemical characteristics
- ☐ Biological properties
- ☐ Constituents and percentages of constituents
- ☐ Analytical methods and results
- ☐ Projection of waste volume to be disposed
- ☐ Quantity of banned waste being disposed
- ☐ Frequency of disposal
- ☐ Period of time waste has been and will be disposed
- ☐ Handling procedures
- ☐ Waste treatment before, during and after disposal
- ☐ Liquid phase mobility information
- ☐ Gas/particulate mobility
- ☐ Solid phase mobility
- ☐ Dust generation potential
- ☐ Gas-liquid phase interactions
- ☐ Persistence/degradation potential in unit and environment
- ☐ QA/QC demonstration

Waste Transformation and Immobilization

- ☐ Estimation of quantity and quality of leachate formation
- ☐ Waste/waste compatibility, interaction, reaction products
- ☐ Waste/liner compatibility
- ☐ Assessment of biodegradation potential
- ☐ Assessment of oxidation/reduction potential
- ☐ Assessment of immobilization due to insolubility
- ☐ Assessment of photodegradation potential
- ☐ Assessment of immobilization due to hydrolysis
- ☐ Assessment of immobilization due to adsorptivity

Site Characterization

- ☐ Surficial geology and soils (regional and local)
  - ☐ Topography
  - ☐ Soil types
  - ☐ Soil properties
  - ☐ Depth to bedrock
- ☐ Bedrock geology (regional and local)
  - ☐ Stratigraphy and lithology
  - ☐ Seismic activity of area
  - ☐ Assessment of ground motion potential and degree

- ☐ Geologic cross sections
- ☐ Degree of bedrock faulting and fracturing
- ☐ Rock characterization

☐ Ground-water hydrology (regional and local)

- ☐ Water table map
- ☐ Seasonal variations in the water table
- ☐ Identification of all aquifers and aquitards
- ☐ Characterization of all aquifers
- ☐ Vertical and horizontal hydraulic conductivity
- ☐ Aquifer interconnection
- ☐ Description of ground-water monitoring program
- ☐ Monitoring QA/QC documentation

☐ Surface water hydrology

- ☐ Location of all watersheds
- ☐ Map of drainage patterns
- ☐ Map of floodplain
- ☐ Flood analysis

☐ Meteorology/climatology

- ☐ Wind rose
- ☐ Precipitation records
- ☐ Temperature records
- ☐ Relative humidity records
- ☐ Maps of storm tracks

Monitoring Plan

- ☐ Media to be monitored
- ☐ Type of monitoring to be conducted at the unit
- ☐ Location of monitoring stations
- ☐ Frequency of monitoring at each station
- ☐ Specific hazardous constituents to be monitored
- ☐ Implementation schedule for the monitoring program
- ☐ Equipment used at the monitoring stations
- ☐ Sampling and analytical techniques employed
- ☐ Data recording/reporting procedures

Waste Mobility

☐ Unsaturated zone soils

- ☐ Soil sampling
- ☐ Soil testing

☐ Unsaturated zone physical properties

- ☐ Volumetric water content
- ☐ Degree of water saturation
- ☐ Bulk density
- ☐ Pressure potential
- ☐ Relative permeability
- ☐ Unsaturated hydraulic conductivity
- ☐ Water capacity
- ☐ Water diffusivity

☐ Leachate characteristics affecting mobility

- ☐ Leachate characterization
- ☐ Leachate interactions

- ☐ Secondary leachate evaluation
- ☐ Evaluation of transport mechanisms
- ☐ Evaluation of fate of contaminants in unsaturated zone
- ☐ Vapor concentration of constituents at the source
- ☐ Vapor pressure of constituents
- ☐ Solubility data for constituents
- ☐ Activity coefficient
- ☐ Henry's Law constant
- ☐ Background measurements for air
- ☐ Assessment of volatilization potential

Modeling Evaluation

- ☐ Model accounts for all transport mechanisms
- ☐ Model appropriate for petitioned waste
- ☐ Data input accurate and verified
- ☐ Model tested under field conditions
- ☐ Model is accurate over long time periods
- ☐ Limitations of model
- ☐ Model inputs adequately documented
- ☐ Model outputs appropriate and reasonable

Assessment of Environmental Risk

- ☐ Identification of all exposure pathways and routes
- ☐ Identification of all potential receptors
  - ☐ Wildlife
  - ☐ Vegetation
  - ☐ Identification of sensitive or endangered species
- ☐ Assessment of bioaccumulation through the foodchain

Uncertainty Analysis

☐ Natural Events

- ☐ Climatic fluctuations
- ☐ Glaciation
- ☐ Stream erosion

- ☐ Magmatic activity
- ☐ [redacted]displacement
- ☐ [redacted]strophism
- ☐ [redacted]
- ☐ [redacted]fracturing
- ☐ Dissolution
- ☐ Sedimentation
- ☐ Flooding
- ☐ Undetected features (i.e. faults, lava tubes)
- ☐ Meteorites
- ☐ Fires
- ☐ Hurricanes
- ☐ Tornadoes
- ☐ Earthquakes
- ☐ Ground motion

☐ Waste/facility-induced events

- ☐ Thermal effects
- ☐ Chemical effects
- ☐ Mechanical effects
- ☐ Modification of hydrologic regime

☐ Human-induced events

- ☐ Improper design or operation
- ☐ Past intrusions
- ☐ Future intrusions
- ☐ Intentional intrusion
- ☐ Perturbation of ground-water system
- ☐ Biosphere alterations

Where Can I Obtain Additional Information Concerning "No Migration" Variances?

Additional information on "no migration" variances is available from EPA Headquarters in Washington, D.C. Facilities considering submitting a petition are strongly encouraged to meet with the Agency before preparing the petition to assess the exact nature of the information required in the "no migration" demonstration and the level of detail appropriate for the petition. Questions concerning petitions and requests for petition meetings should be directed to:

U.S. Environmental Protection Agency
Permits and State Programs Division
401 M Street, S.W.
Washington, D.C. 20460
Telephone: 202/382-4782

Questions concerning these and other RCRA requirements can also be directed to the RCRA/Superfund Hotline at 800/424-9346 or, in the Washington, D.C. metropolitan area, 202/382-3000. The Hotline can also provide assistance in obtaining copies of Federal regulations and other relevant guidance documents.

The following is a list of selected documents which may be of value to potential petitioners:

Permit Applicants' Guidance Manual for the General Facility Standards. 1983. EPA SW-968.

Permit Applicants' Guidance Manual for Hazardous Waste Land Treatment, Storage, and Disposal Facilities. 1984. EPA 530 SW- 84-004.

Hydrologic Simulation at Waste Disposal Sites. 1982. EPA SW-868.

Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods Third Edition, 1986. EPA SW-846.

A Method for Determining the Compatibility of Hazardous Wastes. EPA 600/2-80-076.

A Guide for Estimating the Incompatibility of Selected Hazardous Waste Based on Binary Chemical Mixtures. 1986. ASTM P-168.

Soil Properties, Classification, and Hydraulic Conductivity Testing. 1984. EPA SW-925.

Criteria for Identifying Areas of Vulnerable Hydrogeology Under the Resource Conservation and Recovery Act. 1986. NTIS 86- 224946.

RCRA Facility Investigation Guidance Manual, Interim Final. EPA 530/SW-89-031, February, 1989.

Solid Waste Leaching Procedure. 1984. EPA SW-924.

Waste Analysis Plan Guidance Manual. 1984. GPO 055-000-00244-4.

Construction Quality Assurance for Hazardous Waste Land Disposal Facilities, Draft. 1985. EPA/530 SW-85-021.

RCRA Groundwater Monitoring Technical Enforcement Guidance Document, 1986.

Surface Impoundment Clean Closure Guidance Manual, Interim Final. October, 1987.

Superfund Public Health Evaluation Manual. EPA/540-1-86-060.

Guidelines for Carcinogenic Risk Assessment. 51 FR 33992-34003.

Guidelines for the Health Risk Assessment of Chemical Mixtures. 51 FR 34014-34025.

Integrated Risk Information System (IRIS) Chemical Files. EPA/600/8-86/032b.

DRAFT

APPENDIX

INTERIM FINAL

AIR PATHWAY ASSESSMENT METHODOLOGY FOR "NO-MIGRATION" DEMONSTRATIONS

JULY 1989

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1.0 INTRODUCTION

The Environmental Protection Agency (EPA) promulgated a final rulemaking (51 FR 40572) that established the overall framework for the land disposal restrictions as mandated by the Hazardous and Solid Waste Amendments (HSWA) of 1984. A major requirement of the HSWA is that all hazardous wastes must meet treatment standards based on performance of best demonstrated available technology before placement into the land. Otherwise, the owner/operator is prohibited from land disposal of the waste. Section 3004(d), (e), and (g) also provides an opportunity for generators, owners, and operators to either individually or collectively petition for a variance from the prohibition against land disposal of hazardous wastes not meeting Agency standards. In order to receive a variance, a petitioner must successfully demonstrate that there will be "no migration" of hazardous constituents from the disposal unit or injection zone for as long as the waste remains hazardous [3004(d)(1)].

A "no-migration" demonstration methodology applicable to air releases has been developed. This methodology has been based on consideration of the emission and atmospheric dispersion potential of gaseous and particulate air contaminants from land disposal units. Typical hazardous waste disposal units such as land treatment, surface impoundments, and landfills have the potential for air contaminant emissions even with the application of control technology. Local wind conditions will result in the transport of these air contaminants beyond the unit boundary. Therefore, the air pathway assessment methodology presented in Section 2, which accounts for these emission/dispersion mechanisms, is recommended for "no-migration" demonstrations. An example application of this methodology is presented in Section 3.

Regulations currently are being developed by EPA under Section 3004(n) of HSWA to control air emissions from hazardous waste treatment, storage, and disposal facilities. In addition, the National Emission Standards for Hazardous Air Pollutants (NESHAP) applicable to benzene are currently being revised. The Occupational Safety and Health Administration (OSHA) has promulgated air contaminant standards which address short-term exposures. Compliance with 3004(n), NESHAP and OSHA requirements are a necessary prerequisite for approval of a "no-migration" petition.

2.0 AIR PATHWAY ASSESSMENT METHODOLOGY

2.1 Overview

The intent of a "no-migration" petition is to demonstrate that there will be no transport of hazardous constituents at hazardous concentrations from the disposal unit. For air pathway assessments, "no-migration" is defined as constituent-specific (gaseous and particulate) air concentrations which are protective of human health and the environment. Therefore, the point(s) of compliance for air pathway assessments should include location(s) of the maximum air concentration at the unit boundary. This approach involves the application of standard emission and dispersion models to estimate air concentrations for comparison to available inhalation health criteria.

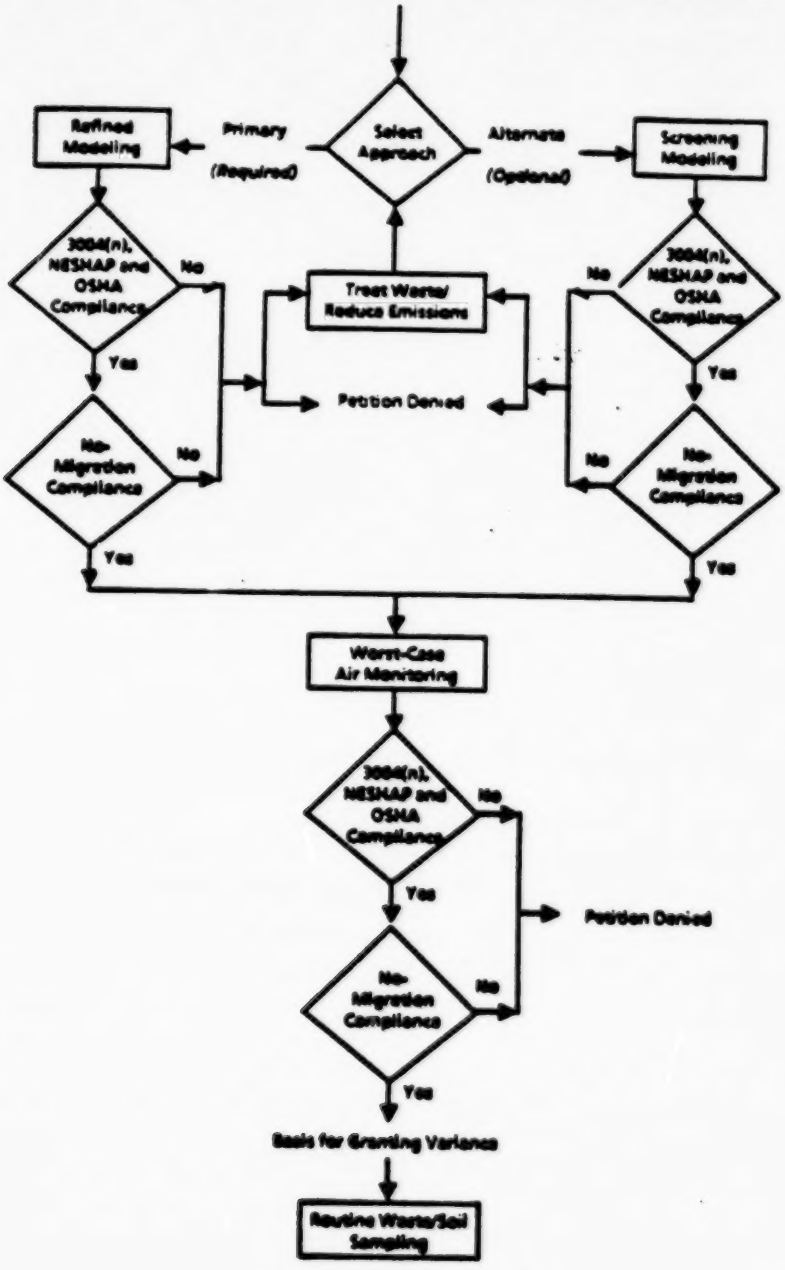
A standard exposure height of 1.5m should be used for "no-migration" air pathway assessments to evaluate air concentrations relative to health criteria. This value corresponds with a typical inhalation height and facilitates the application of standard modeling/monitoring methods for particulates as well as gaseous releases. The vertical profile of air concentrations may be quite significant but highly variable within 1m of the surface due to various microscale atmospheric effects. It is frequently difficult to obtain representative air concentration samples or to accurately characterize dispersion conditions at exposure heights of less than 0.1m on or at the edge of area sources such as land treatment areas, surface impoundments, and landfills. For example, particulate samplers with inlet heights significantly less than inhalation height would have the potential to suck up non-suspendable particulates from the soil surface in a manner similar to a vacuum cleaner and, thus, would not provide representative air pathway exposure data. In addition, alternative approaches such as headspace analysis for volatile organic constituents as well as air monitoring near the source surface will significantly overestimate inhalation potential.

A combination of modeling and monitoring approaches can be used to estimate the maximum air concentration at 1.5m on the unit boundary. An overview of a recommended air pathway assessment methodology for "no-migration" demonstrations is illustrated in Figure 2-1. This methodology consists of the following major components:

- Conduct of an emission rate/dispersion modeling assessment prior to submittal of a "no-migration" petition.
- Conduct of worst case emission rate and air monitoring assessment prior to submittal of a "no-migration" petition.

FIGURE 2-1

AIR PATHWAY ASSESSMENT METHODOLOGY FOR "NO-MIGRATION" DEMONSTRATIONS



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- Conduct of routine waste and soil sampling after a "no-migration" variance has been granted

A modeling assessment should initially be conducted to characterize the air emission potential for the disposal unit and to estimate maximum air concentrations at the unit boundary. The primary modeling approach is to use refined emission rate and dispersion models. An alternative (optional) approach involves the application of conservative screening models. The screening approach is generally useful to obtain preliminary conservative modeling results. But the refined modeling approach will still be required as the primary basis for evaluation of a "no-migration" petition. Modeling results should be used to determine compliance with 3004(n), the benzene NESHAP and OSHA. If modeling results indicate compliance, then a monitoring assessment should be conducted. Non-compliance results indicate that waste treatment and/or additional measures to reduce emissions would be needed. Based on these control measures, a revised modeling assessment should be conducted If waste treatment/control measures are not adequate for compliance, the "no-migration" petition will be denied.The recommended methodology for the conduct of modeling assessments is presented in Section 2.2.

A monitoring assessment should also be conducted (e.g., this may involve a demonstration plot for a new land treatment unit) to evaluate modeling estimates and results should be submitted with the "no-migration" petition. The emission and air monitoring program should be conducted during a period representative of worst-case emission/dispersion conditions. Worst-case conditions provide the best potential to obtain conclusive monitoring results because of the higher concentrations expected relative to analytical detection limits. Emission monitoring results should be used to determine compliance with 3004(n) and the benzene NESHAP. Air monitoring results should be used to evaluate the accuracy of modeling estimates and determine compliance with "no-migration" criteria. Compliance based on this evaluation will be a prerequisite for granting a "no-migration" variance while non-compliance monitoring results will be a basis for petition denial. The recommended methodologies for the conduct of monitoring assessments for "no-migration" demonstrations are presented in Section 2.3.

Subsequent routine waste and soil sampling and analyses will be required to determine compliance with modeling assumptions and results used for the "no-migration" petition. The recommended methodologies for the conduct of routine sampling assessments after a "no-migration" variance has been granted are presented in Section 2.4.

2.2 Modeling Methodology

The air pathway assessment modeling methodology for ›-migration" demonstrations involves applying emission rate and dispersion models. These modeling results are used to estimate the maximum air concentrations at the unit boundary for comparison to health-based criteria. The methodology consists of five steps as follows (see Figure 2-2):

- Step 1 - Obtain Source Characterization Information: This information (e.g., unit size, waste quantity, etc.) is needed to define the emission potential of a disposal unit. The specific source data needed will be a function of the input requirements of the emission rate and dispersion models selected.

- Step 2 - Select Release Constituents: Unit and waste-specific information should be used to identify potential release constituents for modeling purposes.

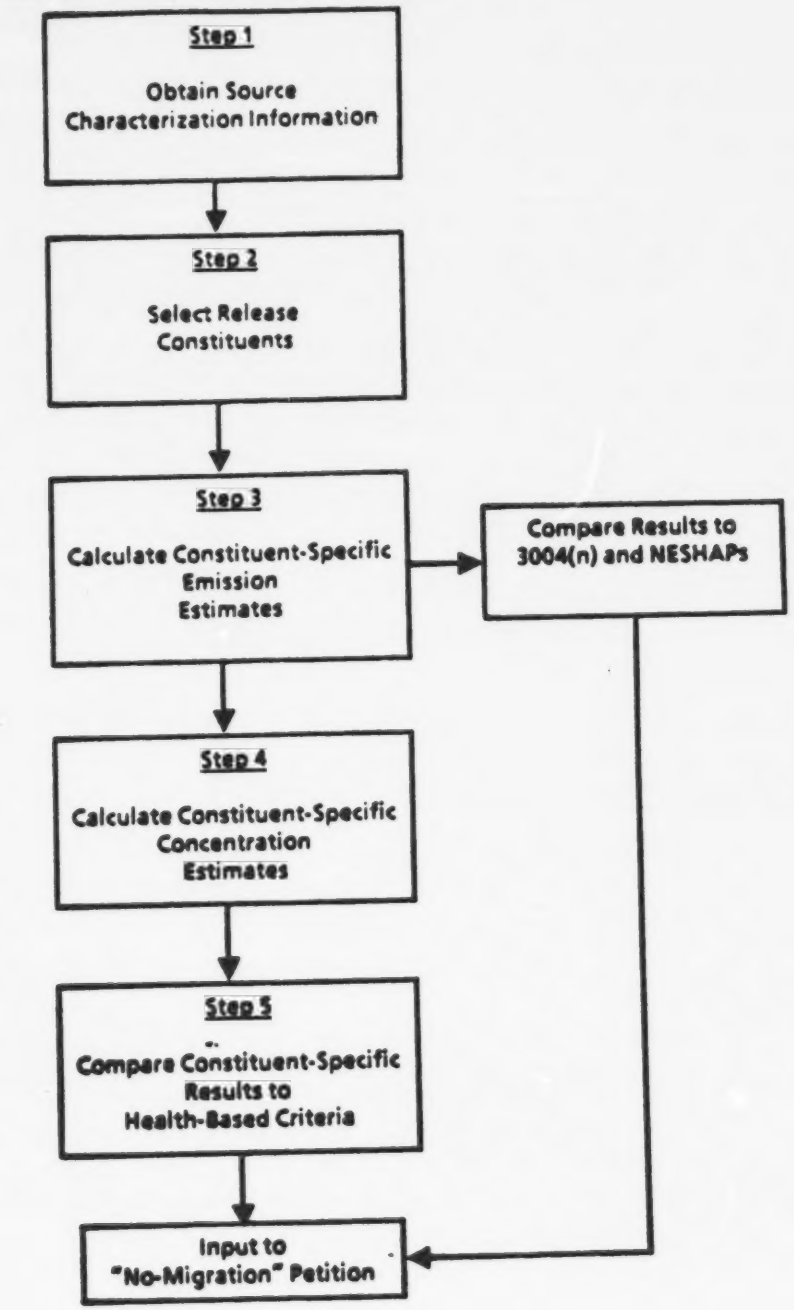
- Step 3 - Calculate Emission Estimates. Unit-specific emission models should be used based on source conditions identified in Step 1 for constituents identified in Step 2. These modeling results will provide constituent-specific emission rate estimates. These constituent-specific emission rates should be used as input for Step 4.

- Step 4 - Calculate Concentration Estimates: Emission rates from Step 3 should be used to calculate concentration estimates at the unit boundary. Standard dispersion models (see Section 2.2.2) should be used to obtain these concentration estimates.

- Step 5 - Compare Concentration Results to Health-Based Criteria: Concentration results from Step 4 should be compared to constituent-specific, health-based criteria presented in the interim final RCRA Facility Investigation (RFI) Guidance (U.S. EPA, May 1989). Chronic exposures for carcinogens and toxicants should be evaluated by comparison of the estimated maximum annual (1-year) concentration directly to the annual average concentrations (based on RFI health criteria and assuming a 70-year exposure). Therefore, the health criteria concentrations should not be exceeded during any calendar year. Furthermore, credit should not be taken for reduced 70-year average concentrations if the unit will not be operational for the full 70-year period. The Health Index approach as presented in the RFI Guidance (U.S. EPA, May 1989) should be used to account for additive inhalation health effects of constituents (with toxicants and carcinogens being treated separately). Interpretation of the ambient concentration

FIGURE 2-2

MODELING METHODOLOGY OVERVIEW



estimates should account for the uncertainties associated with the source/waste characterization data, as well as modeling inaccuracies. Short-term modeling estimates should be used to evaluate compliance with OSHA requirements.

An expanded discussion of this five-step process is available in the Air Release Screening Assessment Methodology. (U S. EPA, May 1989).

Hard copies of modeling input and output files and supporting calculations should be submitted with the "no-migration" petition. Submittal of modeling files on floppy disk would help facilitate review of the air pathway assessment by the U.S. EPA. Wind direction (wind rose) plots should also be submitted with the petition for each modeling period.

Recommended emission rate methods and dispersion modeling methods as they apply to "no-migration" demonstrations are presented in Section 2.2.1 and 2.2.2, respectively.

2.2.1 Emission Rate Modeling

Air emission models can be used to estimate constituent-specific emission rates based on waste/unit input data for many types of waste management units. (An emission rate is defined as the source release rate for the air pathway in terms of mass per unit time.) The models applicable to land disposal units are based upon theoretical considerations and have been evaluated against pilot-scale and field test results. Often these models are empirically correlated. However, because the models attempt to predict complex physical and chemical phenomena, they should be used carefully. These models are generally considered accurate within an order of magnitude (assuming representative input data) for short-term emission rate estimates. Accuracies for long-term estimates are more favorable and are also limited by mass balance considerations (i.e., the emission rate cannot exceed the waste input to the disposal unit).

The potential variability of the waste and unit input data should be accounted for in the modeling assessment. Therefore, a sensitivity analysis of this variability relevant to emission rate estimates should be conducted to determine the level of confidence associated with the emission modeling results.

Emission rate estimation methods for gaseous emissions should be based primarily on CHEMDAT6 (or updated versions as available) models. Emission factors (as discussed in the following subsection) should be used to estimate fugitive emissions of particulate matter.

Gaseous Emissions

The modeling methodology for "no-migration" demonstrations to estimate gaseous emissions is based on the application of CHEMDAT6 air emission models developed by EPA's Office of Air Quality Planning and Standards and available from NTIS. (U.S. EPA, December 1987). These models are applicable to volatile organics as well as semi-volatile constituents which enter the air pathway via volatilization. CHEMDAT6 includes air emission rate models for the following land disposal units:

- Land treatment
  - Oil film surface
  - Land treatment oil
- Disposal impoundment
- Landfills
  - Open landfills
  - Closed landfills

Comprehensive technical information regarding these CHEMDAT6 models is presented in the Hazardous Waste Treatment, Storage and Disposal Facilities (TSDF) Air Emission Models. (U.S. EPA, December 1987). This reference also presents air emission rate models for many other sources.

Short-term as well as annual emission rate modeling should be conducted to evaluate compliance with 3004(n), the benzene NESHAP and OSHA requirements.

For some applications, Step 4 - Calculate Concentration Estimates will not warrant the use of emission models because it can be assumed that all the volatile wastes handled will eventually be emitted to the air. This assumption is generally appropriate for highly volatile organic compounds placed in a disposal unit like a surface impoundment. In these cases, balance mass calculations can be used since the air emission rate can be assumed to be equivalent to the disposal rate, and an emission rate model may not be required. This assumption is valid because of the long-term residence time of wastes in the disposal units. In open units like surface impoundments, a substantial portion of the volatile constituents will frequently be released to the atmosphere within several days. But the use of the mass balance approach is only applicable if waste transformation and degradation processes do not produce significant quantities of the constituents being evaluated. For more complex situations (e.g., land treatment units and landfills), air emission models can be used to obtain a more refined release rate.

Fugitive Particulate Matter

Trace metal and semi-volatile constituents of fugitive particulate emissions are of concern for "no-migration" demonstrations. Emission factors should be used to estimate these fugitive particulate air emissions. Emission rate estimates should be based on standard methodologies used by the U S EPA in the following documents:

- Hazardous Waste TSDF - Fugitive Particulate Matter Air Emissions Guidance Document, (EPA-45013-89-019), U.S. EPA, March 1989 (review draft and subsequent versions as available).

- Control of Open Fugitive Dust Sources, U.S. EPA, September 1988a.

- Compilation of Air Pollutant Emission Factors (AP-42), U.S. EPA, September, 1985 and Supplement 8 - September 1988b)

Emission estimates should be representative of inhalable particles (i.e., particles 10 microns or less in diameter). Soil concentration estimates (representative of inhalable size particles) from the surface of the unit should be used as modeling input to determine constituent-specific emission rates. These soil concentration estimates should be used to define the upper limit for unit operating conditions and, therefore, should account for the potential accumulations of the constituents being evaluated. Guidance on developing particulate emission estimates is provided in Hazardous Waste TSDF - Fugitive Particulate Matter Air Emissions Guidance Document (U.S. EPA, March 1989).

Potential fugitive particulate emissions due to mechanical disturbances as well as wind erosion should be quantitatively evaluated and presented for "no-migration" demonstrations. The potential for reduced fugitive particulate emissions as a function of moisture or oil and grease content of exposed soil surfaces should be based on Figures 2-3 or 2-4, respectively. However, the applicant must commit to maintain these soil conditions on a long-term basis in order to obtain credit for these mitigative control conditions.

Determination of actual control performance should be addressed in the "no-migration" petition. It should include daily observations and documentation of visible dust emissions (especially during unit disturbance periods and high wind speed events). Routine (weekly) soil moisture and/or oil and grease content sampling from the unit and background conditions is recommended to confirm initial

FIGURE 2-3
WATERING CONTROL EFFECTIVENESS FOR UNPAVED TRAVEL SURFACES
(U.S. EPA, SEPTEMBER 1988a)

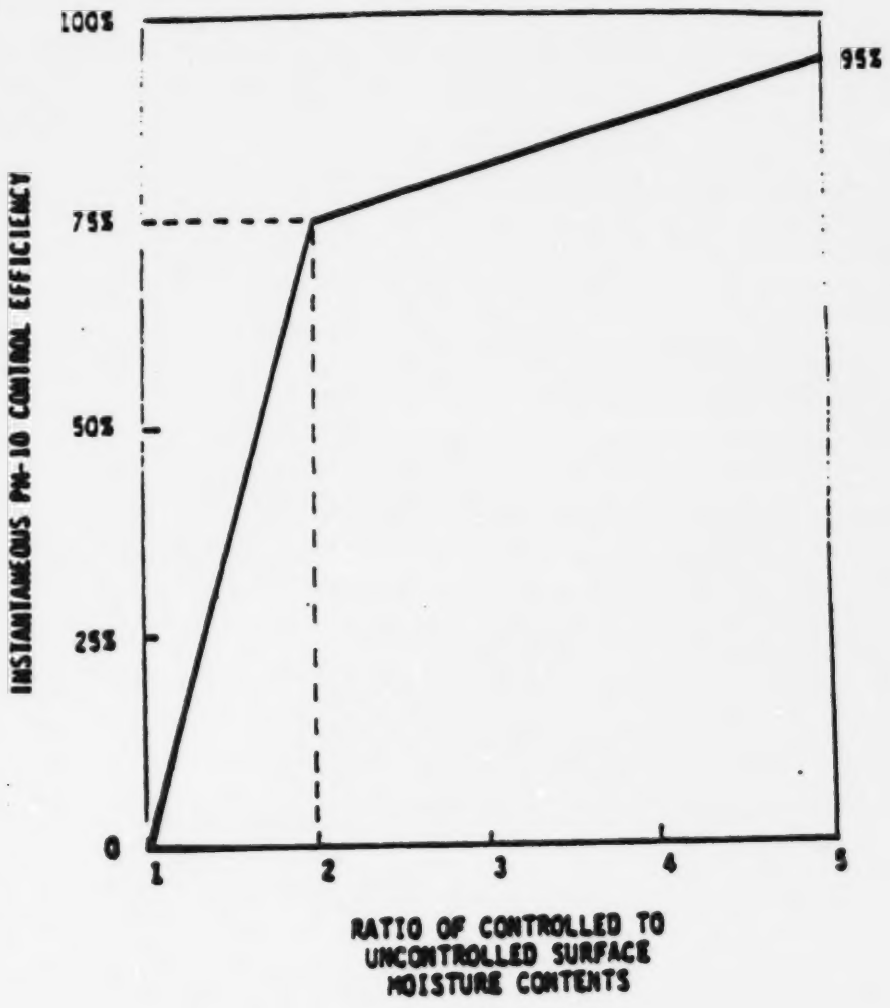
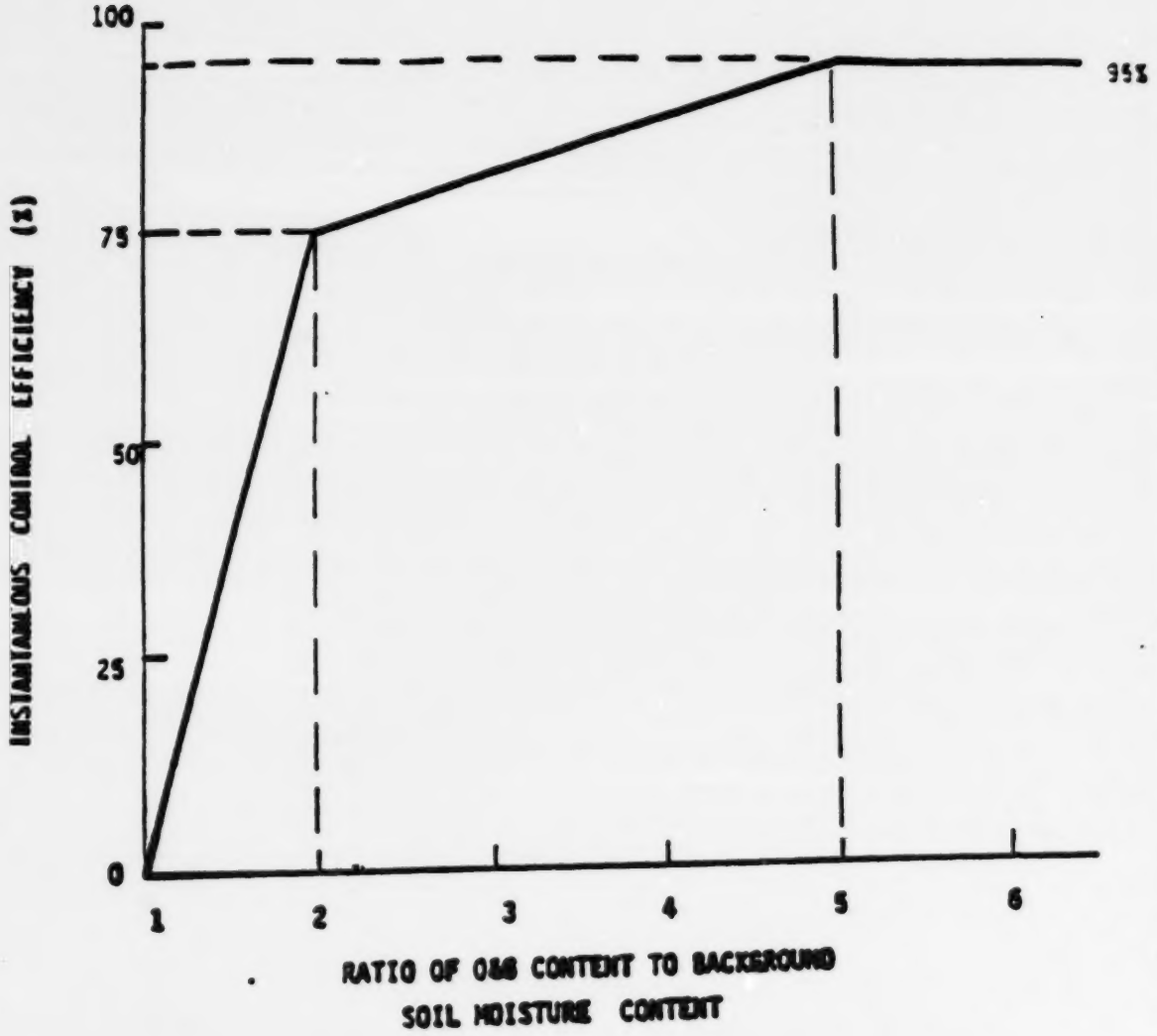


FIGURE 2-4
PROCEDURE FOR ESTIMATING CONTROL EFFICIENCY WITH OIL AND GREASE (O&G) CONTENT AND MOISTURE CONTENT MEASUREMENTS (U.S. EPA, MARCH 1989)



emission modeling/control assumptions. Soil sampling should involve analysis of soil moisture and oil/grease content to estimate mitigative control efficiencies. Appropriate soil sampling and analysis methods for this application are presented in the following references:

- Hazardous Waste TSDF-Fugitive Particulate Matter Air Emissions Document, (Appendix D - Sampling and Analysis Procedures) U.S. EPA, March 1989 (and subsequent versions as available).

- RCRA Facility Investigation Guidance, Section 7 - Waste and Unit Characterization, and Section 9 - Soil, U.S. EPA, May 1989

- Test Methods for Evaluating Solid Waste, U S. EPA, November 1986

Vehicle travel from the land treatment unit to other locations of the facility could result in the "trackout" of contaminated soil. This potential can be reduced by proper management of soil moisture conditions (in general, muddy soil conditions are not conducive to effective land treatment operations). Trackout can also be reduced by use of vehicles which are committed exclusively to the land treatment unit or by the use of routine washing of vehicles before they leave the unit. "No-migration" demonstrations should address unit-specific preventive controls for potential trackout of contaminated soil and should estimate trackout rates.

Wind erosion potential can be reduced by the revegetation of fallow areas and use of berms or shelter belts around the perimeter of the unit. These measures, especially berms, also reduce the transport of large contaminated soil particles due to soil erosion. These soil particles are too large to be suspended in the air and move along the ground surface. "No-migration" demonstrations should take appropriate credit for preventive wind erosion and soil erosion controls. Soil and wind erosion rates for "no-migration" demonstrations should include emission rate estimates with and without preventative emission controls.

2.2.2 Dispersion Modeling

Emission rate values from Step 3 should be used as modeling input to calculate concentration estimates at the unit boundary. Two alternative types of models (i.e., flux models and dispersion models) are candidates for this application.

Flux models can be used to evaluate concentrations at and in the vicinity of an area source (Most disposal units such as land treatment areas, surface impoundments, and landfills can be classified as area sources.) Although these models can be technically sophisticated, they generally lack extensive validation

Standard dispersion models used by EPA for regulatory applications are based on the assumption that the downwind concentration of air contaminants can be characterized by a statistical (Gaussian) distribution. Validation efforts have confirmed the performance of this class of models. Atmospheric dispersion models are typically accurate within a factor of two to three for flat terrain sites (inaccuracy can be a factor of 10 in complex terrains). However, validation studies have been quite limited in regard to receptors near an area source boundary. However, dispersion model predictions for such situations are still considered more dependable than the use of flux models which have little, if any, validation. Therefore, the use of dispersion models is recommended for "no-migration" demonstrations.

The use of the Industrial Source Complex (ISC) model is recommended as a the preferred candidate model for "no-migration" demonstrations. The ISCLT version of the model can be used to calculate long-term concentrations for exposure periods ranging from 24 hours to annual average estimates. The ISCST model is generally used to estimate concentrations for averaging periods of 24-hours or less. Selection of the ISCLT versus ISCST version of the model should be based on matching the averaging time for dispersion modeling with the specific exposure period for the applicable health criteria. The model can be used for both flat and rolling terrain. The ISC model software is available from NTIS and the user's guide is presented in Industrial Source Complex (ISC) Model User's Guide. (U.S. EPA, 1987).

Additional guidance on dispersion model selection and application is available in the Guideline on Air Quality Models (Revised). U.S. EPA, July 1986).

Meteorological data (i.e., wind and atmospheric stability summaries) are necessary dispersion modeling input. Data from a representative National Weather Service station can be used as available. It is preferable to evaluate five years of meteorological data and base "no-migration" estimates on the one-year period associated with the highest predicted concentration. Alternatively, onsite meteorological data can be used. If less than five years of data are available (as is frequently the case for on-site data) the available data should be compared to long-term offsite data to evaluate the representativeness of the data selected for modeling to estimate air concentrations during the

worst-case year. Guidance on the conduct of meteorological programs is presented in On-Site Meteorological Program Guidance for Regulatory Modeling Applications. (U.S. EPA, June 1987).

Two alternative dispersion modeling approaches are available for "no-migration" demonstrations, as illustrated in Figure 2-5. The primary (required) approach involves the direct application of the ISC dispersion model based on site-specific and unit-specific input data. The alternative (optional) screening approach involves the application of modeling results available for a limited set of source and meteorological conditions. This screening approach can be used to obtain preliminary, conservative modeling estimates. Based on these results, the applicant may decide whether to consider waste treatment or proceed to refined modeling. Following is a description of each of these approaches.

Primary Approach

The conduct of a dispersion modeling study based on site/unit-specific model input data is the preferred approach for "no-migration" demonstrations. This refined modeling approach involves the direct use of the ISC dispersion model to provide direct estimates of concentrations. This involves the following tasks, as indicated in Figure 2-5:

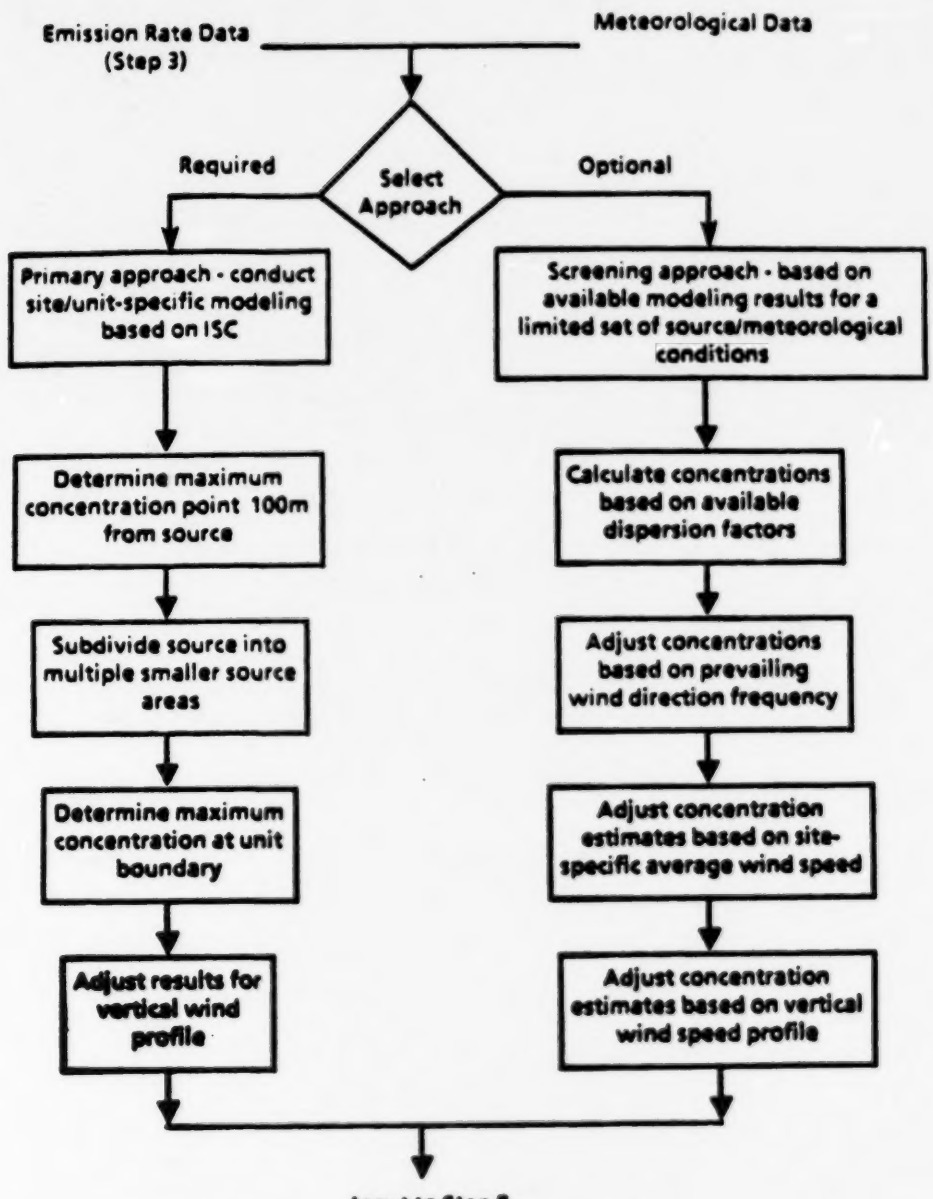
- Determine the point of the maximum concentration 100m from the unit boundary.
- Subdivide the source area into multiple smaller source areas.
- Determine the maximum concentration at or beyond the unit boundary (generally the maximum concentration will be at the unit boundary).
- Adjust modeling results, as necessary, to account for the vertical wind profile.

Dispersion modeling estimates should be obtained which are representative of unit boundary conditions. A specialized modeling approach is generally needed for standard dispersion models, such as ISC, in order to obtain concentration estimates near the boundary of a large area source. This approach consists of the following tasks, assuming a ground-level area source:

- Determine the point of maximum concentration at approximately 100m from the unit boundary using standard dispersion modeling methods. This is a standard computational distance for the ISC model. Concentration estimates should be obtained for at least 16 sectors of 22.5 degrees each (a finer resolution is acceptable) in order to select the point of maximum concentration. These results will provide the basis to identify the sector associated with the maximum concentration.

FIGURE 2-5

STEP 4 - CALCULATE CONCENTRATION ESTIMATES


Emission Rate Data (Step 3)
Meteorological Data
Select Approach
Required
Optional
Primary approach - conduct site/unit-specific modeling based on ISC
Determine maximum concentration point 100m from source
Subdivide source into multiple smaller source areas
Determine maximum concentration at unit boundary
Adjust results for vertical wind profile
Screening approach - based on available modeling results for a limited set of source/meteorological conditions
Calculate concentrations based on available dispersion factors
Adjust concentrations based on prevailing wind direction frequency
Adjust concentration estimates based on site-specific average wind speed
Adjust concentration estimates based on vertical wind speed profile
Input to Step 5 - Compare Results to Health-Based Criteria

- Estimate the concentration at the unit boundary for the sector associated with the maximum concentration point located 100m from the unit boundary. (For modeling purposes, a downwind distance of approximately 1m from the unit boundary can be used for this estimate as necessary.) Contributions to the receptor from all sectors should be accounted for

The concentration at 1m from the unit boundary can be obtained from ISC results by subdividing the source area into multiple smaller areas (see Figure 2-6). Computational restraints of ISC require that area sources must be represented as a square or multiple squares. (The ISC user's guide should be consulted for the approach to use for irregularly shaped area sources.) For "no-migration" demonstrations, it is recommended that the land disposal area should be represented by 25 squares of equal area.

The square along the edge of the unit boundary nearest to the point of maximum concentration should be further subdivided if the side of this square is greater than 10m. This approach will ensure a representative concentration estimate at the unit boundary (i.e., 1m downwind).

Concentration estimates for "no-migration" demonstrations should be representative of a 1.5m inhalation height. Meteorological data available for most modeling studies are based on a 10m tower height. Air concentrations are inversely proportional to wind speed. Near the surface, the mean wind speed has been found to increase in proportion to the logarithm of the height. Therefore, wind speed values or modeling results should be adjusted, as necessary, to account for the vertical wind profile. Many standard dispersion models, such as ISC, extrapolate input wind data to a height of 10m for ground level sources. However, 1.5m winds are more representative for this application. Example wind profile adjustment factors for "no-migration" demonstrations are presented in Table 2-1 based on the logarithmic wind profile law. (U.S. EPA, 1974).

TABLE 2-1
EXAMPLE ADJUSTMENT FACTORS TO ACCOUNT FOR THE VERTICAL WIND SPEED PROFILE[a]

Wind Speed Measurement Height X (m)	Wind Speed Adjustment Factor [Ratio of Wind Speed (1.5m) to Wind Speed (Height X)]	Concentration Adjustment Factor (CAF) [Ratio of Concentration (1.5m) to Concentration (Height X)]
20.0	0.7	1.5
15.0	0.7	1.4
10.0	0.7	1.4
5.0	0.8	1.2
2.0	0.9	1.1
1.5	1.0	1.0

[a] Assuming neutral stability and uniform surface roughness.

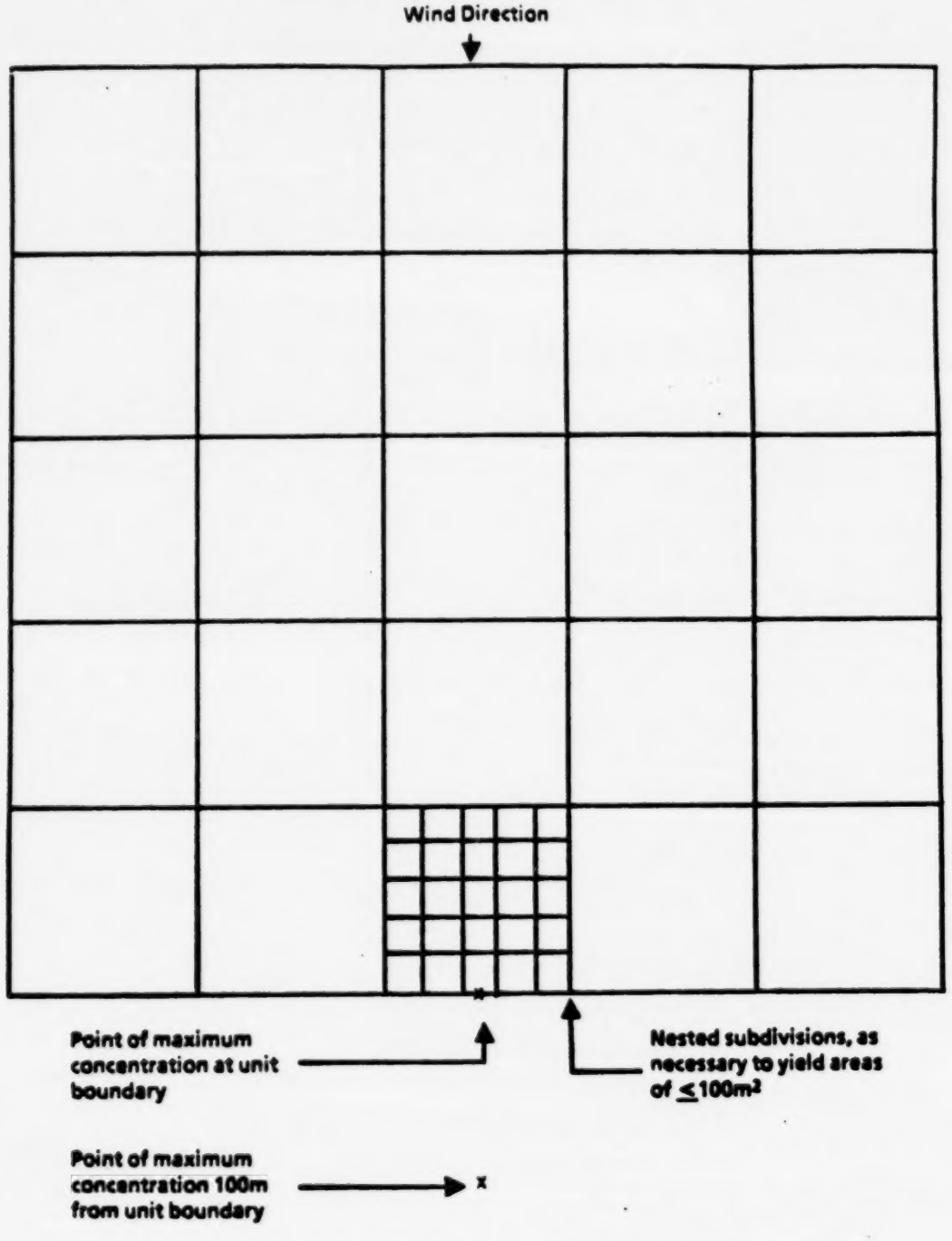
Screening Approach

Screening dispersion modeling is an optional approach to obtain preliminary, conservative estimates of air concentrations. The screening approach involves the manual calculation of concentration estimates based on adjusting dispersion modeling results available for a limited set of source/meteorological conditions. Since these results may be less representative than those based on the refined modeling approach, conservative assumptions should be used. Following are the tasks involved in the conduct of screening modeling as indicated in Figure 2-3:

- Calculate concentration estimates at the unit boundary based on available dispersion factors
- Assume an invariant wind direction
- Adjust concentration estimates to account for the site-specific average wind speed
- Adjust concentration estimates to account for the vertical wind profile
- Apply a safety factor to account for input data and modeling uncertainties.

FIGURE 2-6

EXAMPLE SUBDIVISION OF AREA SOURCE


Wind Direction
Point of maximum concentration at unit boundary
Nested subdivisions, as necessary to yield areas of ≤100m²
Point of maximum concentration 100m from unit boundary
x

This process can be summarized by the following equation.

$$C = ER \times DF \times UCF \times \frac{WDF}{100} \times \frac{10}{WS} \times CAF \times SF \qquad \text{Equation 2-1}$$

Where

- C = annual concentration at unit boundary ($\mu g/m^3$)
- ER = emission rate ($10^6 g/yr$ = Mg/yr)
- DF = dispersion factor for appropriate source area (sec/m^3)
- UCF = unit conversion factor (3.17×10^4)
- WDF = frequency of occurrence of the prevailing wind direction (assumed to be invariant for screening application, i.e. WDF = 100 percent)
- WS = average wind speed 1.5m above ground (mph)
- CAF = concentration adjustment factor to account for the vertical wind profile (dimensionless)
- SF = Safety factor of 10.0 (to account for input and modeling uncertainties)

The product of ER times DF times UCF yields an initial concentration estimate. The emission rate estimates from Step 3 should be used as ER values. Dispersion factor (DF) values can be obtained from Table 2-2 as a function of source area. These DF values are based on ISCLT dispersion equations for a receptor on the downwind unit edge assuming a square area source configuration (with no subdivisions of the area), neutral stability, 10 mph winds at a measurement height of 10m and an invariant wind direction (i.e., the receptor point for calculation purposes is directly downwind of the source 100 percent of the time).

This initial concentration estimate should be adjusted (using the parameters WS and CAF) to account for site-specific wind conditions. Representative National Weather Service or onsite meteorological data should be used as the basis for these adjustments.

The modeling results presented in Table 2-2 are based on a 10 mph wind speed. The average wind speed (WS) at the site should, therefore, be used to adjust these modeling results. Similarly, a concentration adjustment factor (CAF) should be used to account for the vertical wind speed profile

TABLE 2-2

EXAMPLE UNIT BOUNDARY DISPERSION FACTOR VALUES

Unit Area (Hectares)	Dispersion Factors[a] (sec/m^3)
0.01	3.9×10^{-3}
0.04	2.6×10^{-3}
0.25	8.9×10^{-4}
1.00	2.8×10^{-4}
4.00	7.9×10^{-5}
25.00	1.5×10^{-5}
100.00	4.3×10^{-6}
400.00	1.4×10^{-6}

a Based on ISCLT results with the following assumptions:

- Ground-level area source (square configuration)
- Average wind speed of 10 mph at a measurement height of 10m (dispersion factors do not account for the expected lower wind speeds at 1.5m exposure height)
- Invariant wind direction
- Dispersion factors are the maximum value at the unit boundary

Values of CAF are presented in Table 2-1 for a range of wind measurements heights to facilitate scaling concentration modeling results to represent a 1.5m inhalation exposure.

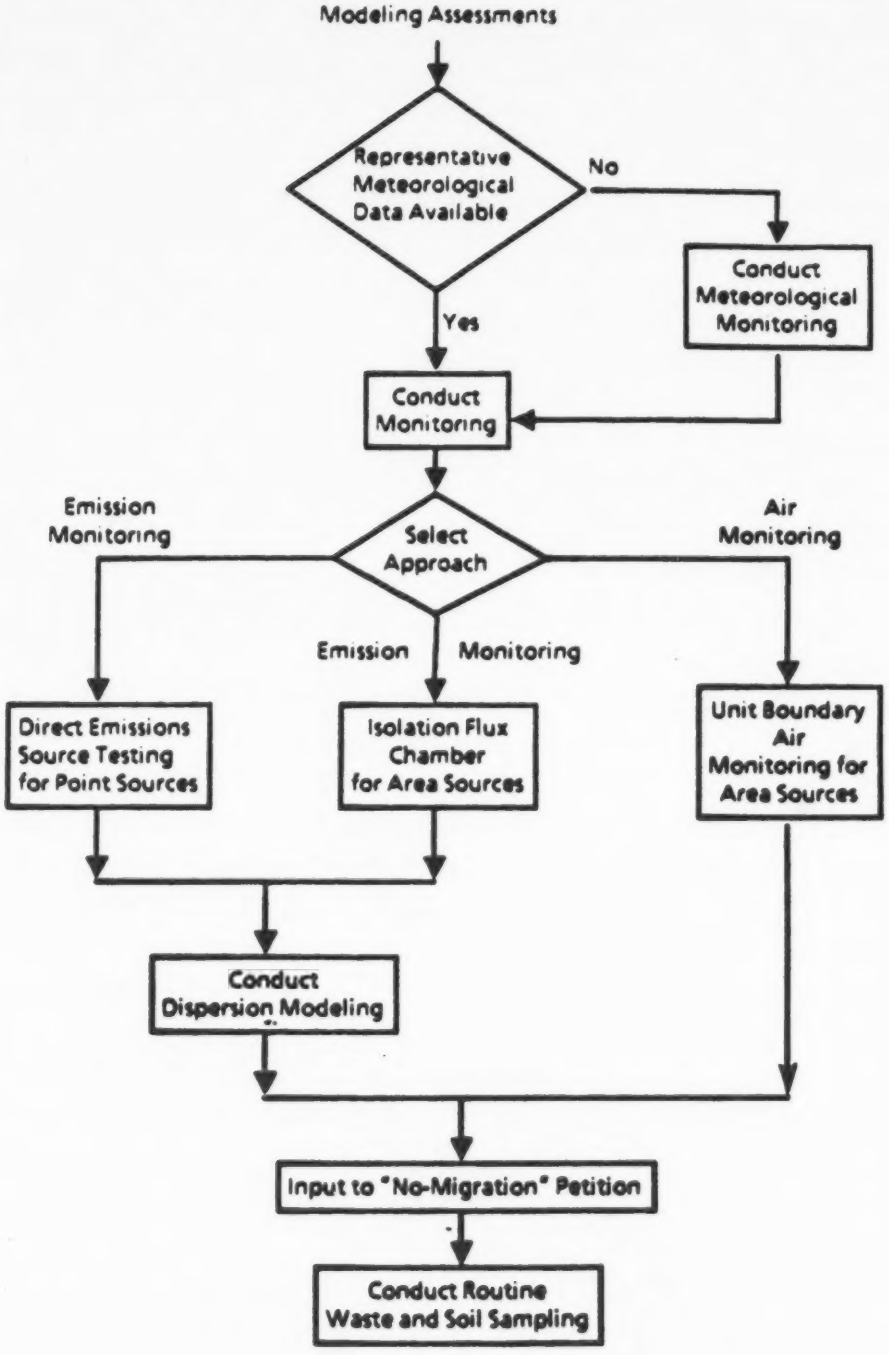
An example application of this approach is illustrated in Section 3.

2.3 Air Monitoring Methodology

For most "no-migration" variances, a monitoring program must be conducted to evaluate modeling estimates (see Figure 2-7). The monitoring program for the air pathway involves emission/air monitoring conducted prior to the submission of the "no-migration" petition. (This may involve monitoring demonstration plots for new land treatment units.) For each sampling medium used a minimum of five sampling days of 24-hours each should be evaluated which include worst-case

FIGURE 2-7

MONITORING METHODOLOGY - OVERVIEW



emission/dispersion events. (Worst-case emission/dispersion events for particulate emissions may not necessarily coincide with worst-case conditions for gaseous emissions.) Monitoring results and quality control data for the first phase should be submitted with the "no-migration" petition.

Emission rate monitoring can be used in conjunction with dispersion modeling to estimate constituent-specific concentrations at the unit boundary. (An appropriate dispersion modeling methodology has been discussed in Section 2.2.) Direct emission sampling should be used for point sources (e.g., vents at closed landfills). An isolation flux chamber may be used for gas-phase area source emission measurements (e.g., land treatment areas). Multiple sampling locations are required to adequately characterize the spatial and temporal variability of emission conditions over an area source. Further guidance on the application of isolation flux chambers is provided in Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber: User's Guide. (U.S. EPA, 1986). (Alternative emission rate monitoring approaches may need to be considered for waste spreading operations). A similar concept is using a portable wind tunnel deployed in the field to estimate potential particulate emission rates due to wind erosion. But emission rate monitoring still requires the use of dispersion modeling to estimate air concentrations. However, emission rate monitoring in conjunction with air monitoring at the unit boundary provides an enhanced basis to interpret modeling results. Emission rate monitoring is the preferred monitoring approach to evaluate emission rate modeling estimates.

Air monitoring at the unit boundary is the preferred approach for characterizing air concentrations. This facilitates the direct measurement of air concentrations at the point of compliance. However, the selection of appropriate monitoring locations is critical to ensure the measurement of the maximum concentration. Also, the monitoring program duration must be adequate to facilitate comparison of monitoring and modeling results for at least five days. Additional recommendations for the conduct of air monitoring programs for gas phase and particulate constituents are presented in the interim final RCRA Facility Investigation Guidance. (U.S. EPA, May 1989).

The sampling approach for inhalable particulates which is generally applicable to many trace metal constituent analyses is well documented in the PM-10 regulations (40 CFR Part 50 - Appendix J and 40 CFR Part 58 - Appendix E). This approach is based on use of a high-volume sampler. However, the potential for sample loss due to volatilization should be evaluated on a constituent-specific basis. The inlet height for this sampler should be 1.5m above the ground surface. Analytical methods for trace metals in particulate samples generally include the application of Atomic Absorption, Inductively-Coupled Argon Plasmography, and Graphite Furnace Atomic Absorption. Additional information

concerning the sampling and analysis of airborne trace metals is summarized in the following document:

> "Toxic Trace Elements Associated With Airborne Particulate Matter: A Review". (Schroeder, et.al., 1987).

Similar guidance for semi-volatiles is presented in the following document:

> "A Review of Sampling Methods for Polyaromatic Hydrocarbons in Air". (Davis, et.al., 1987).

Representative (preferably onsite) meteorological data should be available as dispersion modeling input to calculate concentration estimates based on emission rate monitoring results. Meteorological data (preferably onsite) will also be necessary to interpret air monitoring results. Recommendations on the conduct of meteorological programs are presented in On-Site Meteorological Program Guidance for Regulatory Modeling Applications. (U.S. EPA, June 1987).

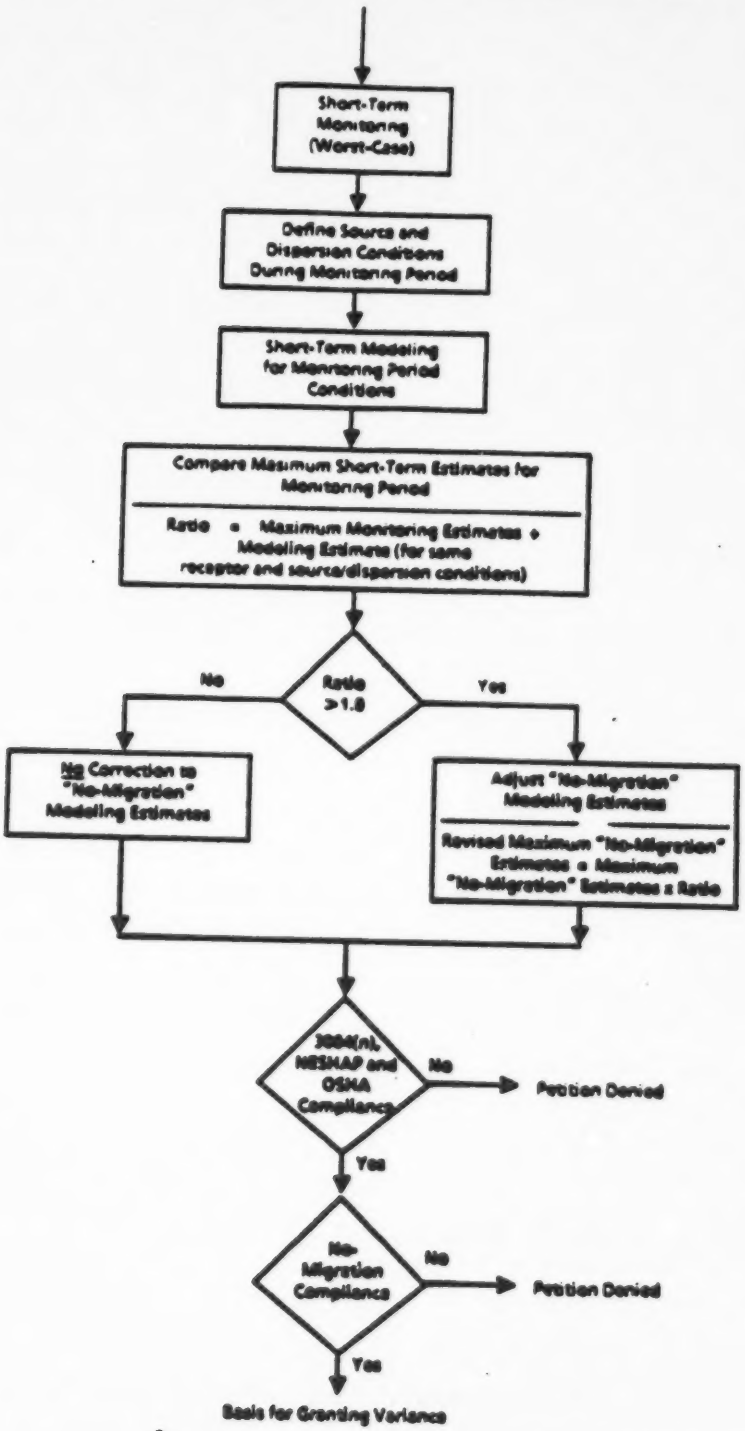
Monitoring results for several indicator constituents (including volatile organics, semi-volatiles and trace metals), PM-10, and total non-methane hydrocarbons should be used to confirm modeling results. Monitoring should be conducted during conditions representative of worst-case emission/dispersion conditions. Worst-case conditions provide the best potential to obtain conclusive monitoring results because of the higher concentrations expected relative to analytical detection limits. Waste and soil samples should also be collected and analyzed for the selected monitoring period.

The utilization of monitoring data for "no-migration" demonstrations is summarized in Figure 2-8. The emissions and air monitoring data representative of worst-case, short-term conditions should also be used to evaluate the accuracy of the modeling estimates developed to support the "no-migration" petition. This should be accomplished by comparing short-term modeling and monitoring results for the same source and dispersion conditions that occurred during the monitoring period. This comparison should be the basis for developing a correction factor to adjust, as necessary, previous modeling estimates used to demonstrate "no-migration" compliance. Short-term versions of the emission and dispersion models should be used, as available, for these comparisons.

A ratio of the maximum monitoring estimates divided by the modeling estimates (which correspond to the same maximum monitoring locations and source/dispersion conditions) should be computed.

FIGURE 2-8

UTILIZATION OF MONITORING DATA FOR "NO-MIGRATION" DEMONSTRATIONS


Short-Term Monitoring (Worst-Case)
Define Source and Dispersion Conditions During Monitoring Period
Short-Term Modeling for Monitoring Period Conditions
Compare Maximum Short-Term Estimates for Monitoring Period
Ratio = Maximum Monitoring Estimates ÷ Modeling Estimate (for same receptor and source/dispersion conditions)
Ratio >1.0
No
Yes
No Correction to "No-Migration" Modeling Estimates
Adjust "No-Migration" Modeling Estimates
Revised Maximum "No-Migration" Estimates = Maximum "No-Migration" Estimates x Ratio
3004(n), NESHAP and OSHA Compliance
No
Petition Denied
Yes
No-Migration Compliance
No
Petition Denied
Yes
Basis for Granting Variance

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Constituent-specific ratios should be determined as feasible. Comparisons should be accomplished for both emission rate monitoring and air monitoring results. If the ratio is greater than 1.0, the maximum "no-migration" modeling estimates should be multiplied by the ratio value to account for modeling under predictions. If the ratio is less than or equal to 1.0, the maximum "no-migration" results should not be adjusted. The revised modeling estimates should be evaluated for compliance with 3004(n), the benzene NESHAP, OSHA requirements and "no-migration" criteria.

2.4 Routine Waste and Soil Sampling

A plan for routine waste and soil sampling should be submitted with each "no-migration" petition. This plan should be implemented to determine on a continuing basis, compliance with "no-migration" conditions presented in the petition. A summary of this routine sampling process is presented in Figure 2-9.

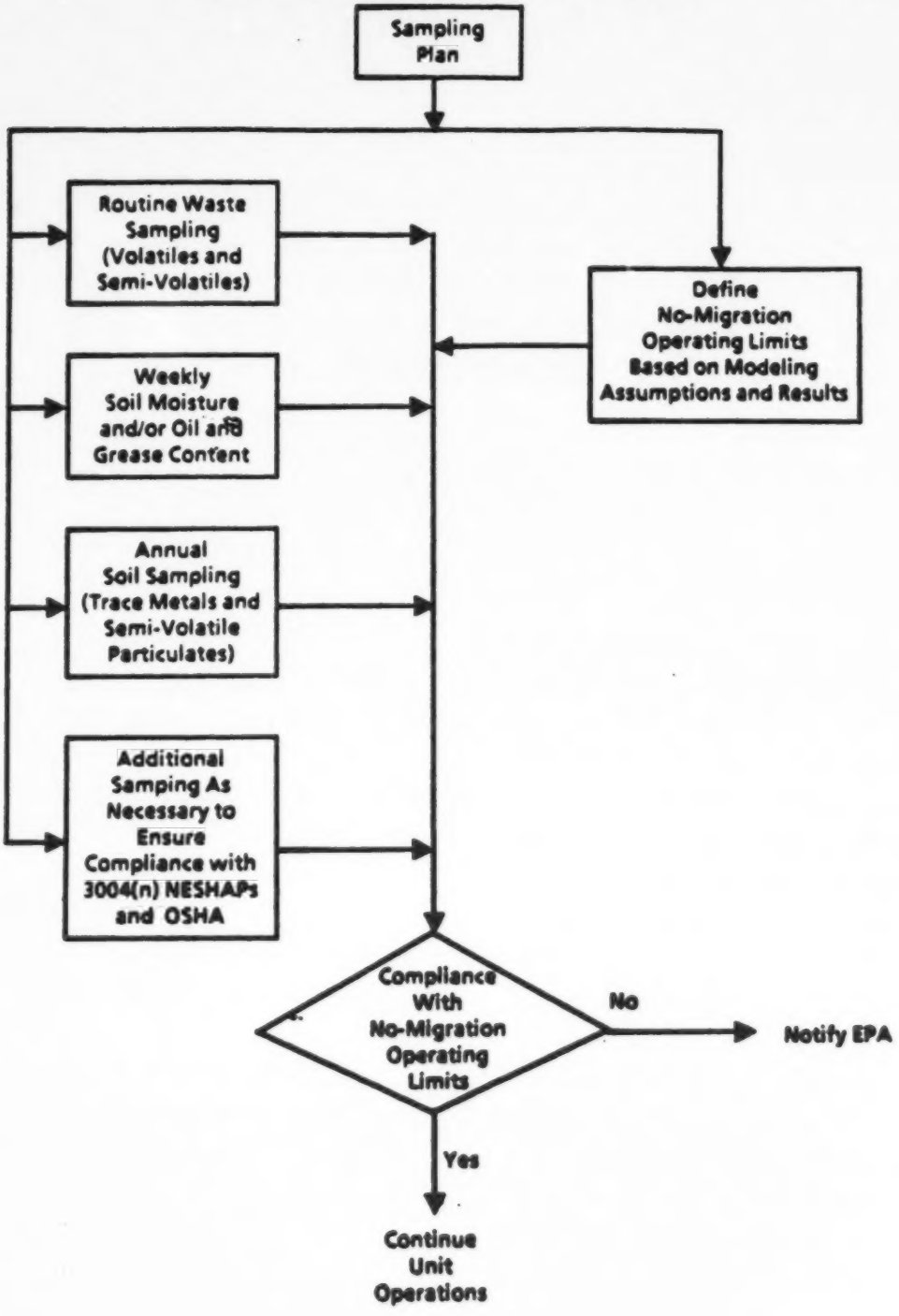
The sampling plan should define specific "no-migration" operating limits. These operating limits should be based on the modeling analyses (assumptions and results) presented in the petition and should ensure compliance with all "no-migration" requirements and applicable 3004(n), benzene NESHAP and OSHA requirements. These operating limits should include, at a minimum, the following factors:

- Annual throughput quantity by volatile and semi-volatile constituents to ensure compliance with chronic health criteria for gaseous emissions
- Soil surface moisture and/or oil and grease content to ensure implementation of fugitive dust emission mitigative controls as assumed in the "no-migration" petition
- Soil sampling (based on composite results for the zone of incorporation) to determine compliance with upper limit concentration assumptions for particulate trace metals and semi-volatiles
- Additional criteria as necessary to ensure compliance with 3004(n), NESHAPs and OSHA.

The compliance with operating limits will be determined by routine waste sampling (generally on a per batch basis), weekly soil moisture and/or oil and grease content testing, annual soil sampling for trace metals/semi-volatiles, and additional sampling as necessary for 3004(n), NESHAP, and OSHA. Appropriate sampling procedures are presented in the following references:

FIGURE 2-9

ROUTINE WASTE AND SOIL SAMPLING PROGRAM


Sampling Plan
Routine Waste Sampling (Volatiles and Semi-Volatiles)
Weekly Soil Moisture and/or Oil and Grease Content
Annual Soil Sampling (Trace Metals and Semi-Volatile Particulates)
Additional Samping As Necessary to Ensure Compliance with 3004(n) NESHAPs and OSHA
Define No-Migration Operating Limits Based on Modeling Assumptions and Results
Compliance With No-Migration Operating Limits
No
Notify EPA
Yes
Continue Unit Operations

- Hazardous Waste TSDF - Fugitive Particulate Matter Air Emissions Document, (Appendix D - Sampling and Analysis Procedures), U.S. EPA, March 1989 (and subsequent versions as available).

- RCRA Facility Investigation Guidance, (Section 7 - Waste and Unit Characterization and Section 9 - Soil), U.S. EPA, May 1989

- Test Methods for Evaluating Solid Waste, U.S. EPA, November 1986.

The unit owner/operator should notify EPA on a timely basis of non-compliance with "no-migration" operating limits.

- Hazardous Waste TSDF - Fugitive Particulate Matter Air Emissions Document, (Appendix D - Sampling and Analysis Procedures), U.S. EPA, March 1989 (and subsequent versions as available).

- RCRA Facility Investigation Guidance, (Section 7 - Waste and Unit Characterization and Section 9 - Soil), U.S. EPA, May 1989.

- Test Methods for Evaluating Solid Waste, U.S. EPA, November 1986.

The unit owner/operator should notify EPA on a timely basis of non-compliance with "no-migration" operating limits.

3.0 EXAMPLE APPLICATIONS

The following case study has been selected to demonstrate the recommended air pathway assessment methodology for "no-migration" demonstrations. These case studies present example modeling results and do not represent the example content of a "no-migration" petition for the air pathway (which should contain a much more detailed documentation of the analyses). Although not discussed in these examples, each case study would require the conduct of a monitoring program to evaluate modeling results (and to adjust for modeling under-prediction, as necessary). Routine waste and soil sampling during unit operations would also be necessary to assure compliance with "no-migration" criteria.

3.1 Gas Phase Emissions - Example Assessment

The case study involves a "no-migration" petition for an existing land treatment unit and includes an example application of the five-step air pathway assessment process as well as use of the "screening" modeling option. Following is a synopsis of the modeling assessment for the new unit.

Step 1 - Obtain Source Characterization Information

The following input information describes the proposed land treatment unit:

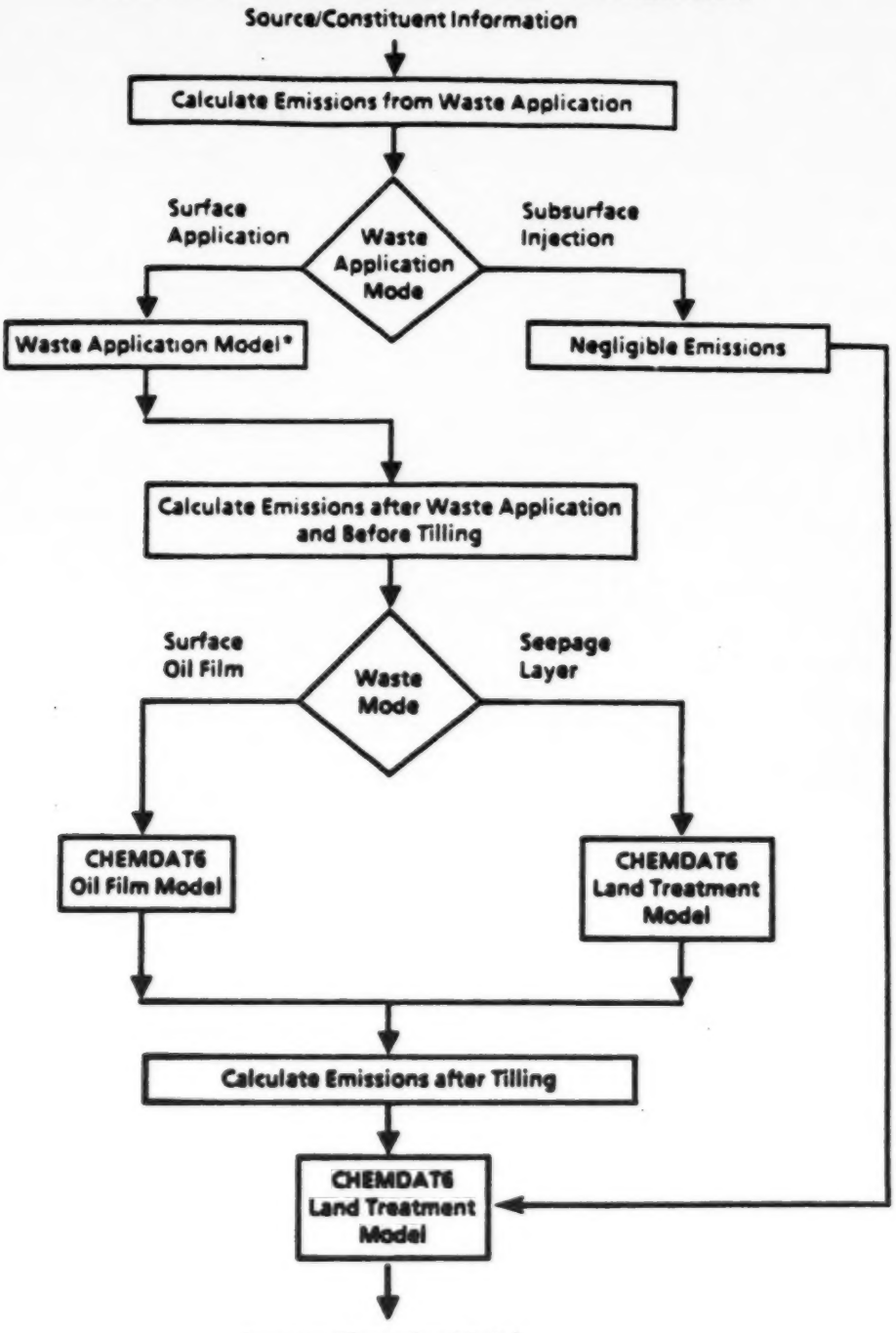
- Land area = 2.5 hectares
- Annual waste throughput = 1,800 Mg
- Oil content of waste = 10 percent by weight
- Tilling depth = 20 cm
- Soil air porosity = 0.5
- Soil total porosity = 0.61
- Average molecular weight = 282 g/g mol

Step 2 - Select Release Constituents

An evaluation of the expected waste constituents indicated that benzene was the constituent with the greatest potential volatility and most restrictive health criteria. Therefore, benzene was selected to represent the total volatile organic concentration (2,000 ppm by weight) of the oil content of the waste. Therefore, the benzene concentration was conservatively assumed to be 2,000 ppm by weight of the oil (i.e., 200 ppm of the waste since the oil content of the waste is 10 percent).

FIGURE 3-1

GASEOUS EMISSION RATE MODELING - LAND TREATMENT UNITS



* Equations presented in Hazardous Waste Treatment, Storage, and Disposal Facilities-Air Emissions Models (U.S. EPA, December 1987)

Step 3 - Calculate Emission Estimates

The emission rate modeling process for land treatment units is summarized in Figure 3-1. Air emissions can occur during three stages (i.e., during waste application, after waste application prior to tilling, and after tilling). The appropriate emission rate models are also a function of the type of waste application (i.e., surface application or subsurface injection) as well as the fate of the oil for surface application operations prior to waste incorporation into the soil (i.e., formation of a surface oil film, oil seepage through a layer of the soil, or the waste is immediately tilled into the soil). For this case study, it has been assumed that the unit will use subsurface injection. Initially, a mass balance approach was used to estimate emissions (i.e., it was assumed that all of the benzene in the waste was released to the air pathway). This approach resulted in an annual concentration which exceeded the health criterion for benzene. Therefore, CHEMDAT6 was used to refine the estimate. Modeling results based on CHEMDAT6 are summarized below for benzene:

Emission Source	Model	Emission Rate
• Subsurface injection	Not applicable	Negligible
• Soil after waste incorporation	CHEMDAT6 land treatment model	0.33 Mg/yr

Short-term and long-term emission rates were also estimated by modeling. These results indicated that waste pretreatment was necessary in order to reduce the volatile organic content necessary to comply with the emission standards. The revised benzene emission rate based on waste treatment was 0.00033 mg/yr.

Step 4 - Calculate Concentration Estimates

The screening dispersion modeling approach was selected for this case study. Representative wind speed data were available from the National Weather Service. The average wind speed is 8 mph (at a measurement height of 10m).

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A maximum concentration representative of chronic exposure at the unit boundary was estimated as follows:

$$C = ER \times DF \times UCF \times \frac{WDF}{100} \times \frac{10}{WS} \times CAF \times SF \qquad \text{Equation 3-1}$$

Where

- C = benzene concentration at unit boundary ($\mu g/m^3$)
- ER = benzene emission rate (assumed to be 0.0033 Mg/yr after waste treatment)
- DF = dispersion factor for source area of 2.5 hectares based on Table 2-2 (interpolated value of 1.2×10^{-4} sec/m^3)
- UCF = unit conversion factor (3.17×10^4)
- WDF = frequency of occurrence of the wind direction (100 percent)
- WS = average measured wind speed (8 mph)
- SF = safety factor of 10.0
- CAF = concentration adjustment factor from Table 2-1 to account for the lower wind speeds at the 1.5m receptor height compared to 10m wind measurement height (1.4)

Therefore:

$$C = (0.00033) \times (1.2 \times 10^{-4}) \times (3.17 \times 10^4) \times \frac{100}{100} \times \frac{10}{8} \times 1.4 \times 10 \qquad \text{Equation 3-2}$$

$$= 0.02 \ \mu g/m^3$$

Step 5 - Compare Concentration Results to Health-Based Criteria

A carcinogenic risk-specific dose of 0.12 $\mu g/m^3$ for benzene is presented in the interim final RCRA Facility Investigation Guidance (U.S. EPA, 1989). The estimated unit boundary concentration from Step 4 (0.02 $\mu g/m^3$) is lower than this health-based criteria for chronic exposure.

3.2 Fugitive Particulate Matter - Example Assessment

Fugitive particulate matter emissions were also characterized for the land treatment unit described in the example presented in Section 3.1. Potential sources of particulate emissions from land treatment units include the following (see Figure 3-2):

- Waste application operations
- Waste incorporation and cultivation operations
- Wind erosion of exposed surface areas.
- Track-out from vehicles.

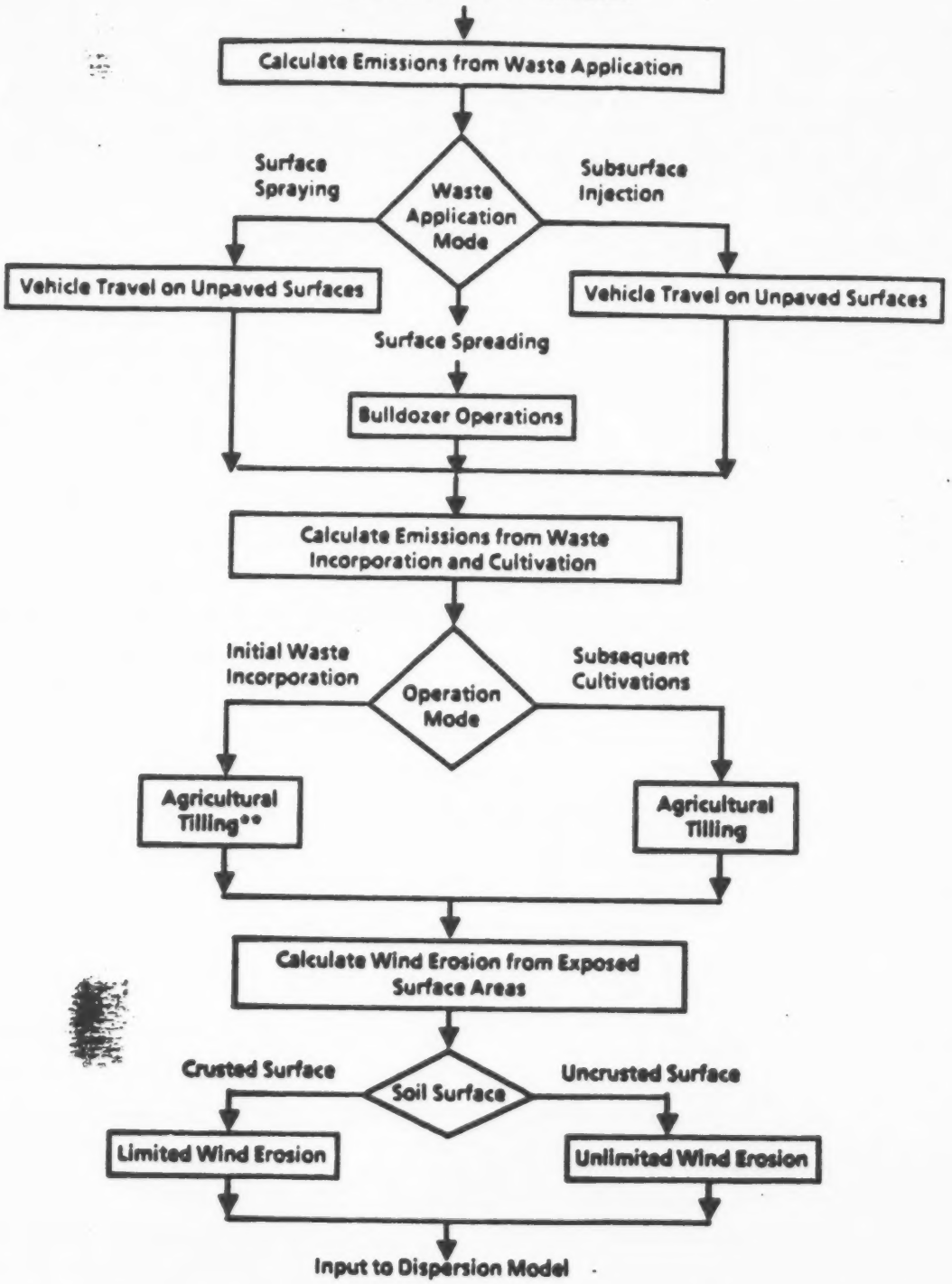
Waste application generally involves a vacuum truck equipped with a delivery system (hose, spray bar, etc.) The waste is either applied on the soil surface or by subsurface injection (into a one foot zone below the soil surface). Potential particulate emissions from these operations are associated with vehicular travel on unpaved surfaces. However, the waste application operation is actually similar to using a tank truck as a control method to apply water or a chemical agent to reduce particulate emissions.

An alternative waste application method is used for waste streams that are not easily pumped. For these situations, a bulldozer or tractor with a blade is used to spread the waste. Bulldozer operations are the primary source of particulate emissions for this alternative waste spreading approach.

The initial waste incorporation into the soil occurs at the same time as waste application for subsurface injection operations. For other operations the waste is incorporated via tilling in a manner similar to agricultural cultivation operations. Subsequent tilling operations generally have a higher potential for particulate emissions compared to initial incorporation (which occurs when soils have a higher oil/grease content and moisture content).

FIGURE 3-2

PARTICULATE EMISSION RATE MODELING - LAND TREATMENT UNITS*



* Emission factors are presented in Control of Open Fugitive Dust Sources (U.S. EPA, September 1988). Equipment track-out of particulates should also be evaluated.

** Emissions generally negligible

Wind erosion is another potential source of particulate emissions from land treatment units. Wind erosion potential is greatest immediately after the soil is disturbed (e.g., by tilling) and when soil moisture conditions and oil/grease content are low.

Equipment track-out potential was considered negligible since a vehicle washing station would be used as a control measure.

The example selected, as discussed in Section 3.1, was based on the use of subsurface injection of the waste. Emission factors and surface soil sampling data from the land treatment unit were used to estimate emission rates for trace metals and semi-volatiles (in particulate phase). These emission rates for cultivation operations were significantly greater than for waste application. However, the greatest potential fugitive particulate emission source (using standard emission factors) was due to wind erosion. Emission rates were adjusted to account for the soil moisture and oil/grease content of the land treatment unit surface which, for this example, could be considered as mitigative controls.

Emission estimates were used as input to the ISCLT atmospheric dispersion model to obtain concentration estimates. The Hazard Index (HI) approach was used to summarize the additive effects of particulate and gaseous phase air releases. Hazard Index values are defined as the ratio of air concentrations at the receptor location (assumed for this application to be at the unit boundary with a inhalation height of 1.5m) to the constituent-specific health criterion. The HI scores are summed over all carcinogenic constituents. A separate HI total is computed for toxicants. Potential health impacts associated with the total HI values for carcinogens or toxicants which are greater than or equal to one are not considered acceptable.

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